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WATER SOFTENING FOR A LARGE POWER AND TEXTILE PLANT

WHILE the necessity for pure water to use in dyeing and other processes of a textile mill is evident and has always been recognized, it has generally been the case that the plant must be located so as to secure a suitable water supply rather than locating the plant to fit other conditions and treating the water which may happen to be available so that it will be suitable for the work. The Burson Knitting Mills, at Rockford, Ill., has, however, proved that it is entirely possible to take water and purity for use in the mill. By sinking an artesian well near the river, but encased so that it gets no seepage from the river, and treating the water thus obtained, a plentiful supply is secured entirely suitable for all purposes, with no trouble in attendance on the apparatus and at a negligible cost. The mills are one of the largest devoted entirely to the knitting of ladies' hosiery in the country, turning out 2,500 dozen pairs a day, and making no other product. The yarn is bought in the natural

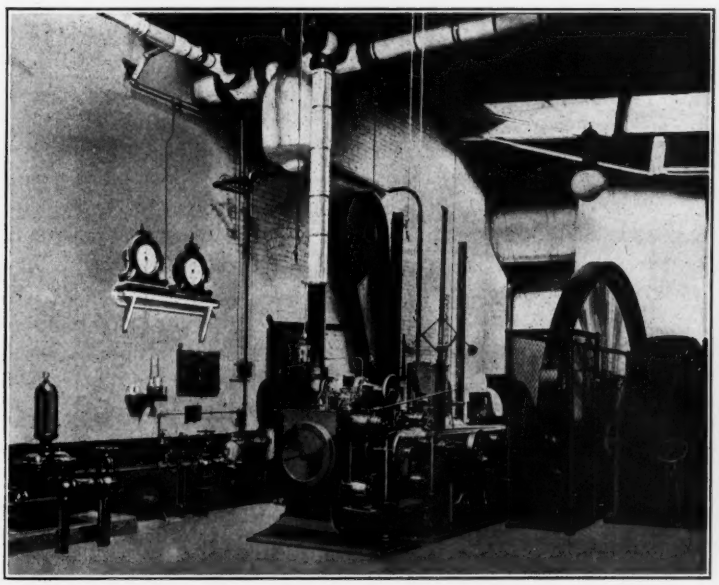


FIG. 1. BATES ENGINE AND GENERAL ELECTRIC GENERATOR IN ENGINE ROOM OF THE BURSON MILLS

FIG. 6. HEATER AND BURNHAM DEEP-WELL PUMP

which of itself is not at all good for mill use and treat it at low cost so that it will be entirely suitable for dyeing and for boiler feed water. Before the installation of the water-softening plant, water was taken from the Rock River, but this had to be filtered, and even then was frequently found far from the desired softness color, worked up in that condition and dyed in the finished product.

While soft water in the dye house is a great necessity, yet the treatment has been so successful that the treasurer of the Mills, Mr. W. E. Hinchliff, states that even if only the boiler-feed were needed he should favor using a water-softening system.

Power Generation

Machinery throughout the plant is electrically driven by means of motors either direct-connected to the machines or connected to batteries of machines, as the best distribution of power may decide. Current for these

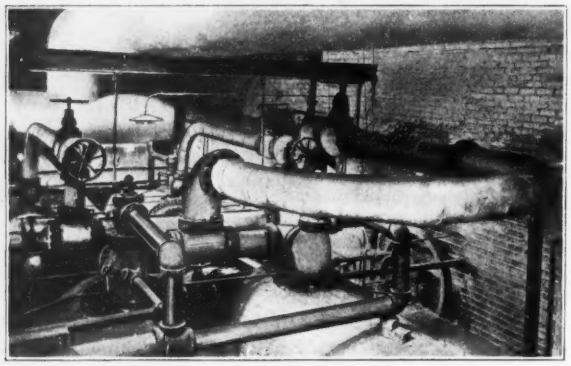


FIG. 2. PIPING OVER BOILERS

motors is furnished by a single generating unit consisting of a Bates-Corliss 250-hp. engine driving a General Electric 200-kw. compound generator, Fig. 1, which supplies continuous current at 230 volts. All motors and lights are run at this voltage, the mercury tube lamp being used for a large part of the lighting in the spinning rooms.

Boiler Plant

Steam for the engines, pumps and industrial processes is furnished by 3 Heine boilers, 2 of 200 hp. and

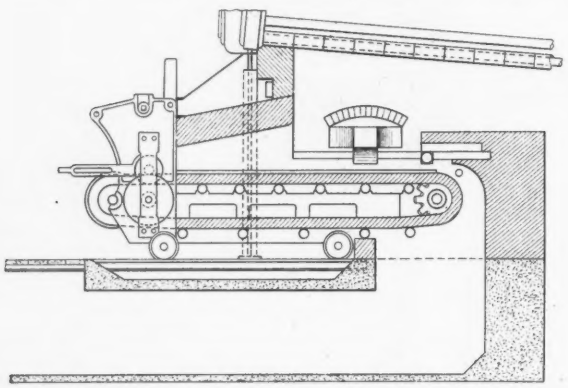


FIG. 3. ARRANGEMENT OF GREEN CHAIN GRATE FURNACES UNDER HEINE BOILERS

one of 500 hp., set opposite each other in a room adjoining the engine room. These are arranged with Green Engineering Co.'s chain grates, the coal being thrown into the hoppers by hand and the ash dropping from the rear of the grates to concrete pits below the boiler setting, as shown in the sectional view of the furnace installation, Fig. 3. These boilers are fitted with Ashton safety valves and with Reliance water columns, and Ashcroft gages.

For driving the stokers a 5-hp. Wachs engine is installed in the engine room, the overhead shaft extending through the wall into the boiler room. Flue gases are carried to uptakes above the boilers, Fig. 2, which are covered with asbestos and which discharge into a reinforced concrete chimney, sectional view of which is shown in Fig. 9.

The Chimney

This is of novel design in that it has a uniform diameter throughout its entire height. The internal diameter is 6 ft. and a lining is carried from base to cap of uniform thickness. The outer shell is graduated in thickness, the steps being made on the inside. The total height of the chimney is 182 ft., the outside diameter 9 ft.

From the boilers steam is taken through automatic stop-check valves which, as well as the other large valves about the plant, were furnished by the Crane Co., and

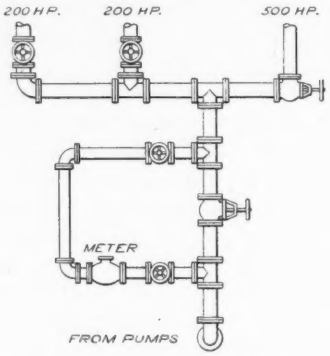


FIG. 4. FEED-WATER METER PIPING

carried through return bends which take care of the expansion, to a header running from the boiler room across the engine room. From this header are taken off branches to supply the main generating unit and the pumps, all of which are located in the engine room. The main continues on through a reducing valve to the dye room and to the old and new mill buildings for supplying steam to the heating engines and, in case of emergency, to the heating coils.

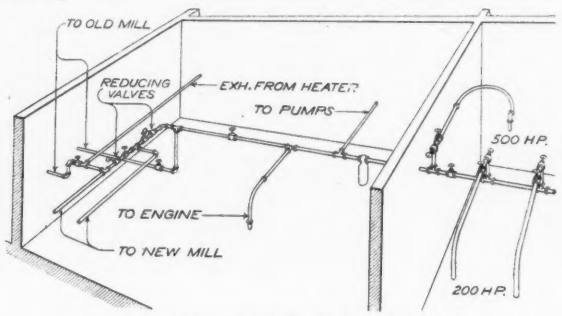


FIG. 5. CONNECTIONS ON STEAM PIPING

Coal and Ash

The efficiency of the firing in the plant is carefully checked up by means of weighing the coal and the use of a Worthington hot-water meter. The coal used is Spring Valley washed screenings, and it is found that the evaporation per pound of coal averages 10 lb. The

installation of the feed piping and the water meter is interesting, and is indicated in Fig. 4.

The system of disposing of ash is an interesing one, the concrete ashpit below the boilers being large enough to take care of several days' product if necessary. The whole space beneath the forward part of the boilers and stoking floor is excavated, giving a cellar with concrete floor. Into this room, outside the building wall, projects

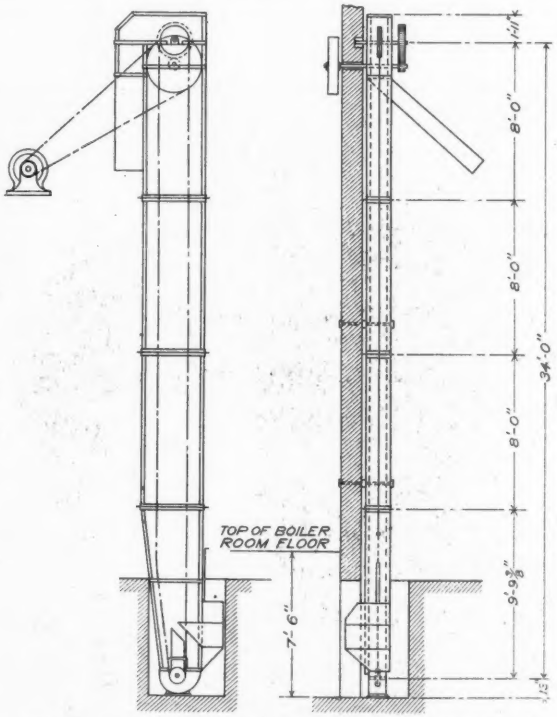


FIG. 7. LINK BELT ASH CONVEYOR INSTALLATION

below the street the boot of vertical Link Belt bucket conveyor, which is driven by a motor located on the inside of the boiler room wall. Ash is thrown into the hopper of the bucket conveyor by hand, is carried to a height sufficient so that it drops by gravity into a concrete chute and discharges into a wagon backed underneath. The ash being so conveniently loaded is in demand for filling, and is carted away without expense to the mills.

Live Steam System

The main engine has a cylinder 18 by 36 in. and takes steam at a pressure of 140 lb., the steam main having inserted in it after passing the boiler room wall a Hoppes separator which insures that dry steam shall be delivered to engines and pumps. The pump and engine supply lines are taken off near the separator, running in opposite directions, and the main then continues on across the engine room through a stop valve and reducing valve to the dye house. The first reducing valve cuts the pressure down to 60 lb., at which it is supplied to the heater engines. A second reduction cuts it down to 2 lb. at which it is supplied to the heaters in the new and old mills in case the exhaust steam is not sufficient.

Exhaust Steam

Into this network of piping comes the exhaust line from the heater, steam passing from it to the old mill or to the new mill, as may be required, or being passed to the dye house when not needed for heating the buildings. The reducing valves are of the G. M. Davis make, with a back pressure valve from Kieley & Mueller. The heating system and engines in the mills were supplied by the B. F. Sturtevant Co., the heating arrangement being made up of coils of pipe with blowers to supply heated air to the different rooms.

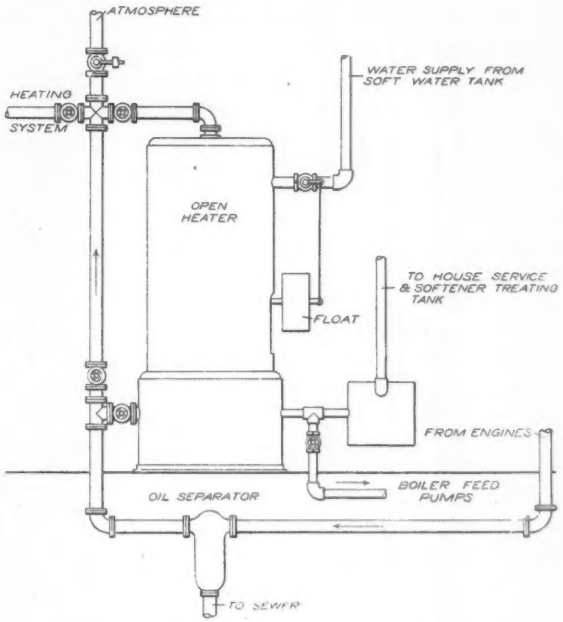


FIG. 8. CONNECTIONS OF FEED-WATER HEATER

Exhaust from the engine passes down under the floor, through an oil separator, and to the bottom of the open feed-water heater. It may pass straight by the heater to atmosphere through a back-pressure valve, or part may pass through the heater to the heating system and the rest go direct to the heating system. The exhaust from the pumps discharges into the same line.

Condensed steam from the heating system goes to a battery of Flinn traps located in a pit in the engine room and passes through these to a receiver tank and float pump which forces the water back to the boilers. As a relay a plunger pump is installed to take water from the open heater or from a cistern and force it direct to the boiler. Besides the Flinn traps used on the returns there are several other traps of the Wright emergency and the V. D. Anderson make on the drips from the separator and at other points as needed.

Feed-Water Supply

Makeup water for the boiler system is supplied through the open heater by a connection with the soft-water tank. From the base of the heater, connection is made to the boiler feed pump, also to the house service pump and to a pump for the treating tank which supplies

a small stream to temper the cold water in winter, as it is found that the treating process operates more rapidly if the water is kept above 40 deg.

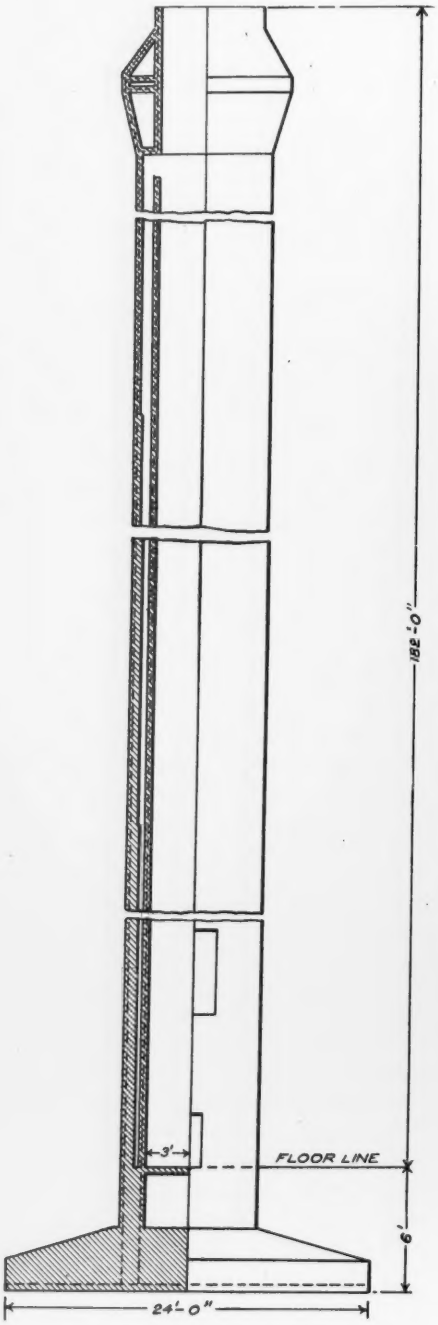


FIG. 9. SECTION OF REINFORCED CONCRETE CHIMNEY

Water-Softening Installation

The supply of water to the heater from the soft-water tank is regulated by a float valve which keeps the level always the same in the heater. Water for the plant comes from a well 300 ft. deep sunk to solid rock. This well has a 10-in. casing and inside this is an 8-in. casing sunk 25 ft. into the rock in order to prevent any possible seepage of river water. The pipe for drawing water from the well is 6 in. in diameter and runs down to the bottom, having the lower section perforated at the sides to permit the water to enter.

To raise the water from this well and force it to the softening apparatus a Burnham deep-well pump 12 by 14 by 16 in. is installed, having a capacity of 48,000 gal.

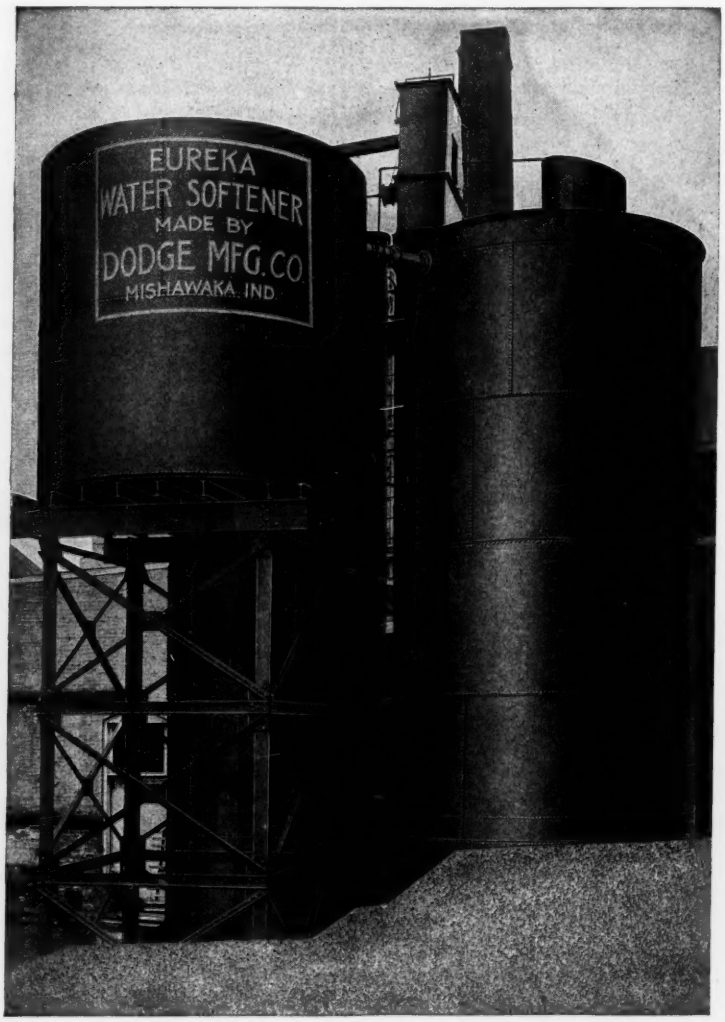


FIG. 10. WATER SOFTENER INSTALLATION BEFORE HOUSING IN

an hour. As a relay to this pump is installed a smaller one of the same make, these 2 drawing and discharging through common mains. The pumps are shortly to be moved and placed near the well in a pit prepared for that purpose, which will decrease materially the amount of piping in the plant and give the pumps a less lift to overcome.

Deep well and house service pumps are equipped with Fisher governors, and engine and pumps throughout the plant are supplied with Manzel Brothers positive feed lu-

bricators. Other pumps used in the water system are a 6 by 8 by 10-in. pump to supply the drinking water throughout the Mills, a house service pump, and a small pump for carrying hot water to the water-softening plant.

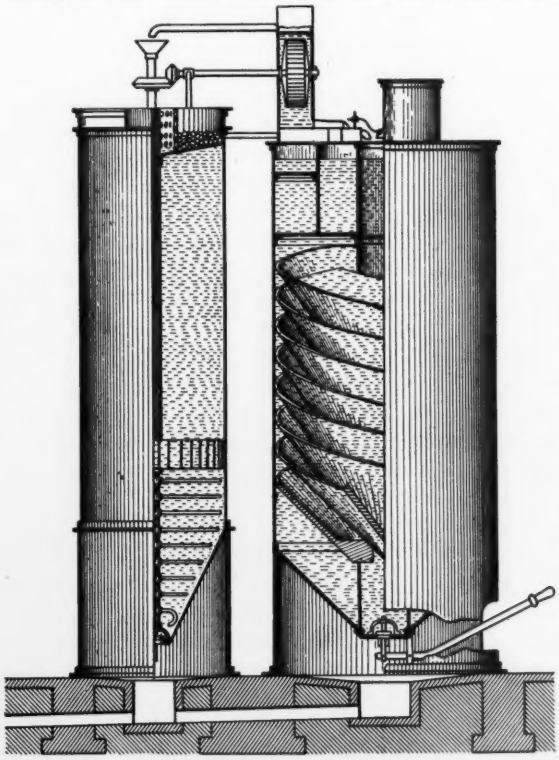


FIG. 11. ARRANGEMENT OF SOFTENER AND TANKS

This softening plant, Fig. 10, which was supplied by the Dodge Manufacturing Co., Mishawaka, Ind., is installed in a building outside the engine room, and consists of 2 tanks, one in which water is treated with lime, the other in which the settling process occurs after the addition of soda ash. The water is forced by the deep well pump to the top of the softener 30 ft. above the ground level, and part of it passes over a water-wheel which, through a shaft and bevel gears, operates the stirrer in the lime treatment tank, Fig. 12.

Part of the water flows to a funnel in the top of the lime tank and passes downward to the bottom, rising through a lime bath to the top, from which it flows across to the decanting tank. The water which passes over the wheel flows direct to the decanting tank and is there mixed with the proper proportion of lime solution and soda ash solution, as shown in Fig. 13. It settles through a central tube at the bottom of the tank and then rises slowly through a series of screw-shaped plates to the top of the decanting tank, from which it overflows into 2 10,000-gal. storage tanks, one of which is seen in Fig. 10. The bottoms of both lime treatment and decanting tanks are conical and provided with valves through which sediment can be blown off to a concrete pit and thence led to the sewer.

This installation is designed to treat 10,000 gal. of water an hour and the 2 storage tanks are always filled in the morning and are nearly empty by night, so that in 10 hr. about 130,000 gal. of water are used. The softener is run for 13 hr. a day, so as to have the storage tanks full at starting time in the morning.

For treating this amount of water about 250 lb. of lime and 53 lb. of soda ash are used each day, and the success of the treatment is shown by the fact that the boilers have been run for 5 months continuously without letting the fire out under them and, of course, without being opened. At the end of that time, when opened for inspection, the heating surfaces were found entirely free from scale, and no cleaning was necessary further than a slight brushing out in the lower tubes. The mud drum is, of course, blown down according to usual good practice.

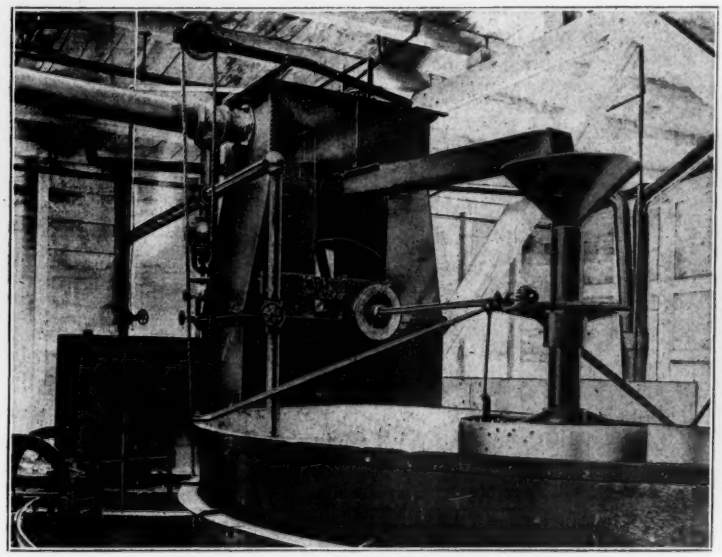


FIG. 12. TOP OF LIME-TREATING TANK, SHOWING WATER-WHEEL AND STIRRER DRIVE

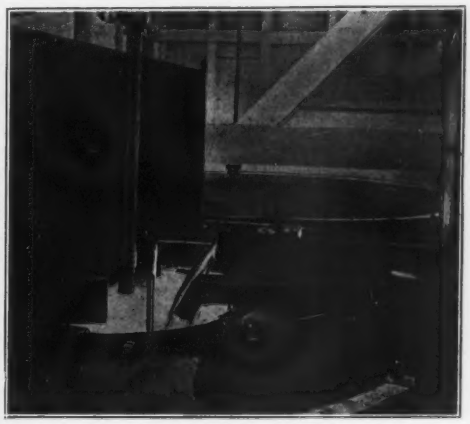


FIG. 13. TOP OF DECANTING TANK

All pumps throughout the plant are Burnhams, made by the Union Steam Pump Co., and are single-cylinder. The pump which supplies water to the softener system is so arranged that water may be sent direct to the dye house if necessary, or the water for the dye house may be taken from the storage tank, the pump meantime sending water to the softener supply.

Small valves used about the plant are of Jenkins Brothers make for both steam and water service. Piping

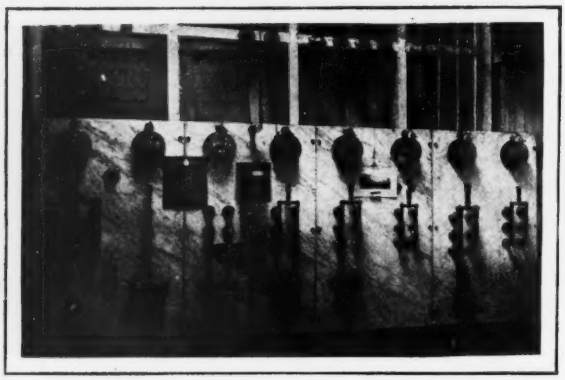


FIG. 14. FRONT OF SWITCHBOARD

is covered wherever it is necessary to prevent condensation or sweating, with 85 per cent magnesia covering supplied by the H. W. Johns-Manville Co., and flange joints in the piping are packed with the American-Goetze Co.'s gaskets, which receive the unqualified endorsement of the chief engineer, A. E. Buske.

Not only is the plant provided with economical methods for making steam, treating water and supplying cur-

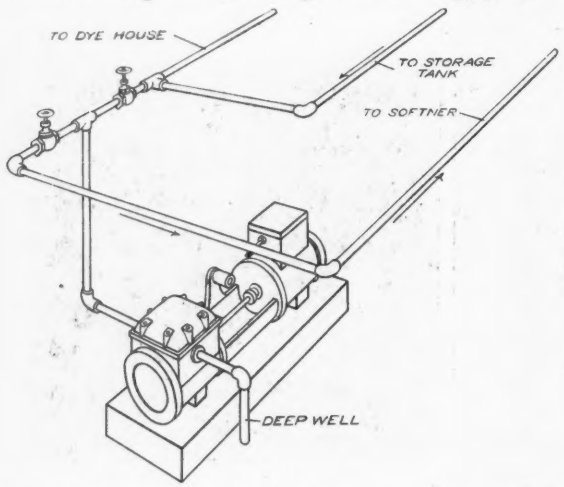


FIG. 15. WATER SUPPLY ARRANGEMENT FOR SOFTENER

rent, but the comfort of employes is looked after, as is evidenced by the fact that a shower bath is installed in the engine room for the use of the engineer's force. Also a suitable lavatory is provided, having a supply of soft water from the treated water tank, hot water from the heater and cold water direct from the well. A convenient kink in this supply is the insertion of pins into the rims of the valve wheels which supply hot and cold water, so that a slight adjustment can be made of either hot or cold water valve until just the right temperature is secured. The pin serves as an indicator to show just how much of a change has been made in the valve opening.

In case of accident to the generating unit, connection can be made by means of a main switch to the lines from the Emerson Power Co's. plant. This switch can also serve to carry current from the Burson plant to the Emerson in case of failure there. The switchboard is arranged with one generator panel, a main station panel, 3 switches for the old building to control the power and lights, and a panel for the new building to control the power and lights, the switchboard having been installed by the Crouse-Hinds Co. In Fig. 14 the left-hand panel is for the generator, the one next it for the interconnection and part of the old mill circuits, the third for the rest of the old mill, and the right-hand panel has been recently installed for the new mill circuits.

FOR A NEW MINING SCHOOL

Of interest to all engineers, especially those connected with mining interests, is a movement started by the Western Society of Engineers and under the direction of a committee consisting of A. Bement, chairman, and Messrs. F. A. Delano, Bion J. Arnold, John M. Ewen, Isham Randolph and R. W. Hunt. A statement sent out by them, giving the purpose of the committee, is as follows:

The State University of Illinois is second in importance in the country, and among all the American universities ranks fifth on the basis of attendance. Notwithstanding this, it has no school of mines or department of mining engineering, although Illinois is the second largest coal mining state in the country, and the only state products exceeding the value of its mineral output are those of agriculture and manufacturing.

The State University has long maintained departments of civil, mechanical and electrical engineering as well as agriculture, of which the latter has been of untold value to the agricultural interests, but mining has been entirely neglected, with the result that this great industry has suffered seriously, and the loss of life and destruction of property are increasing with great rapidity. Thus the interests of the people in general, as well as those engaged in the mining business, require a higher degree of skill in the conduct of this industry. Therefore, the Western Society of Engineers, through its President, Andrews Allen, has appointed this committee to draft a memorial for presentation to the State Legislature, petitioning for the establishment of a department of mines at the State University.

WHEN STOPPING A MOTOR, first open the circuit breaker or switch, which will cut in the resistance of the starting rheostat. Never try to stop a motor by pulling open the starting rheostat, as this may result in burning of the field coils.

REMODELING A SECOND-HAND ENGINE

By Charles H. Taylor

SOME time ago the firm with which I am employed decided to install an electrical plant to do its lighting, and, as is often the case, began by purchasing a second-hand layout, simply because it was cheap. After a good deal of skirmishing around by our purchasing agent, an outfit was discovered with a sufficiently low price, having a Crocker-Wheeler direct-current 11.5-kw. generator in comfortable condition, driven by a vertical slide valve engine, 9 by 9 in.

As soon as the rig was dumped into the engine room I received orders to get her going as soon as

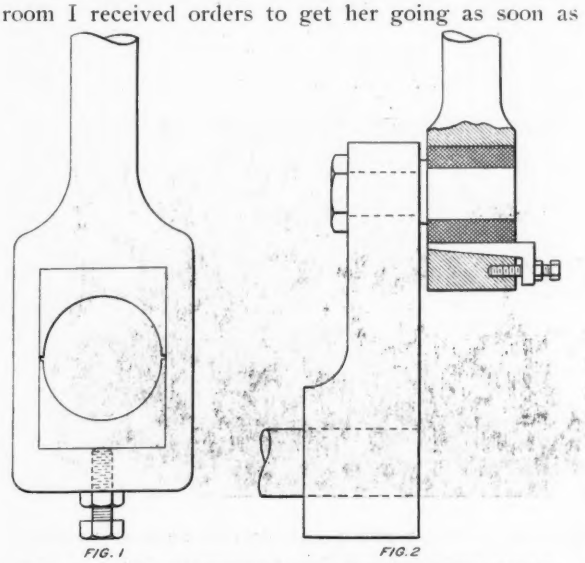


FIG. 1. THE CONNECTING ROD END AS FIRST BUILT
FIG. 2. METHOD OF REMODELING CONNECTING ROD

possible, and a force of men were set at work putting up the wiring. No time was allowed to overhaul; just put her up, pipe her up and turn on steam.

We did it and turned on steam, but that was as far as it went. The engine was a veritable trip hammer, and ran hot all over. After cooling her down with the hose we took down the crankpin brasses and found that they were brass to brass and nipped badly at the edges, so that the oil grooves had been entirely worn out, and the sharp edge of the box had acted like a scraper to take all the oil off the pin.

The crankpin itself was found to be badly out of round, and also badly scored. As this was of the removable type we took it out and turned it off in the lathe. The brasses were filed down, eased away at the edges, and new oil channels cut in each box by laying a strip of brass bent to the curvature of the box and using it as a guide for marking off. A bent chisel, such as is used for grooving, did the rest.

In fitting the boxes, a small quantity of red lead was applied with the finger to show where the box bore hardest, and after quite some scraping a pretty good fit was obtained.

On this engine, the brasses had always been adjusted by means of a steel set screw with lock nut at the bottom of the connecting rod, as shown in Fig. 1. The result was that at every adjustment, after running a short time, the set screw was driven up into the bottom of the box, which became loose again, and in addition the box was pounded out of shape, thus causing heating.

The connecting rod was removed, the inside of the outer end planed off on a bevel, the rod being made with solid end. As the engine was of the side crank type with boxes held on the pin by a thick flange secured by a cap screw tapped into the end of the pin, a taper key was made on the same angle as the inside of the connecting rod end and a hole drilled into the face of the rod.

Into this hole a stud bolt was tapped, fitted on the outer end with an adjusting nut and a lock nut

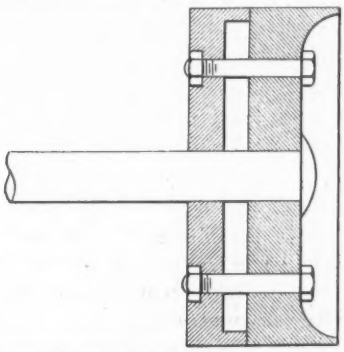


FIG. 3. LENGTHENING PISTON TO REDUCE CLEARANCE

to hold the key in place, as shown in Fig. 2. This gave a good solid bearing to the boxes, and a convenient method of adjusting the crosshead was fixed in the same manner.

Upon inspecting the cylinder and valve the clearance was found to be ⅜-in. when the piston was at the top center and 2.5 in. when at the bottom center. Was it any wonder that she pounded and devoured steam?

The piston was of the solid type with snap rings; this was removed and a hollow casting turned to the same diameter as the piston; the piston was faced up in the lathe, as were also the edges of the casting. This casting was drilled in the center to let it slip over the piston rod, making rather a loose driving fit, as shown in Fig. 3. Six holes were bored through the piston and corresponding holes in the casting, and bolts put in a driving fit. After screwing up the nuts the ends of the bolts were slightly riveted over to prevent working loose.

By this means the clearance of 2.5 in. was reduced to 0.5 in. The valve was planed down and scraped to a bearing, and in resetting the valve a little more lead was given at the lower end on account of the added weight of the piston. Upon starting up we had a very different running engine, which was not extravagant in the use of fuel, and which ran without keeping the nerves of the neighborhood on the ragged edge.

MODERN DAMS FOR WATER POWER DEVELOPMENT

VARIOUS estimates of the available unconserved water power of the streams of the United States place the amount between the wide limits of 10,000,000 and 30,000,000 hp. If the supply be conserved by means of storage it may mount up to the stupendous total of 150,000,000 hp., and with this enormous amount at our very doors, of which scarcely 2 per cent has yet been utilized, it is high time that the engineer should consider the construction of the dam as well as that of the boiler from which his power may be derived.

So far as first cost is concerned the wooden crib dam is manifestly the cheapest. But when maintenance and durability are considered the tables are turned and it becomes the most expensive. Aside from the shortage of water, even the possible leakage during the dry months, when every drop counts, may be so great as to seriously affect the available power.

As compared with the wooden dam one constructed of masonry must be of massive construction always carried down to ledge rock in order to get an absolutely sure foundation. Generally speaking the cost of such a dam is considerably greater than one built of reinforced concrete, for it requires fully 60 per cent more material for its construction.

Reinforced Concrete

In behalf of the reinforced concrete dam it may be said that on account of its light weight and broad base it reduces the load on the foundations to a fraction of that in the solid dam. The weight of the dam itself and the pressure of the water upon it is uniformly distributed over the base, whereas in the masonry dam the water pressure on the vertical upstream side produces concentration of and often excessive pressure on the "toe" of such a dam. For these reasons it is unnecessary to carry the foundations of the concrete-steel dam down to ledge rock. Such a dam is always tight, it is not affected by ice, is practically indestructible and increases in strength with age; hence it requires no expense for upkeep.

In the masonry dam the margin of safety is never more than 2 to 2.5 times the necessary stability, and in a majority of cases it is much less, especially under flood conditions; in the concrete steel type it is never less than 5 under any condition.

Reinforced concrete dams are built in a variety of designs determined primarily by the nature of the river bottom and the head of water, affected to some extent by minor considerations. They are all characterized, however, by a gradually inclined deck forming the water barrier on the upstream side, supported by buttresses in all cases except where the head is very low. In general they may be divided into 2 groups, the open front and the closed front or apron dams, according to whether the overfall of water is natural or constrained; that is to say, whether it is allowed to fall vertically or is deflected in its course. Types of these are illustrated herewith through the courtesy of the Aberthaw Construction Co., of Boston, Mass.

Types of Dam

On firm ledge foundation with moderate head the open front type is the most used. It is cheaper, amply strong, and serves its purpose in all cases. The natural overfall has here no chance to sweep under and endanger the dam's stability. A modified form used to a great extent on rivers subjected to severe ice gorges is known as the curtain dam. It differs from the former by extra stiffening of the crest and by the addition of a curtain or turned down extension on the down stream side for projecting the water and ice a greater distance from the foot of the dam.

FIG. 1. OPEN FRONT APRON DAM OF CONCRETE AND STEEL, SUITABLE FOR LEDGE FOUNDATION AND MODERATE HEAD

For high heads it is necessary to direct the overflow still further by an apron or covering on the down stream side so that the water finally approaches the river bottom in a nearly horizontal direction. The dam where the apron is stopped off half way between the crest and the river bottom and ends in a horizontal discharge, is a type which is without doubt the most desirable, whatever the head of water, provided the river bed is of ledge rock.

Under the combined conditions of high head and soft bottom means must always be provided for breaking the force of the overfall of water and for gently bringing its flow to a horizontal sweep at the bed of the river. Otherwise the dam is certain to be undermined. It is evident therefore that the apron type must be employed, it being similar in outline to that used on ledge with high head, except that the spread upon a soft bottom must be considerably greater than upon a ledge.

Whether the bottom is of stone or gravel, sand or clay, it is necessary in order to insure a good firm foundation, to lay a reinforced concrete floor, anchored

at both sides by concrete cut-off walls, or by sheet piling of wood or steel driven to a sufficient depth to insure tightness to prevent any possibility of washing out it is further necessary to continue the concrete flooring some distance beyond the foot of the dam. In all foundations on soft bottom it is well to provide weep holes through the concrete floor so as to prevent any possibility of the water pressure lifting the dam.

Features of Construction

The general method of construction is similar in both the curtain dam and the apron type. The principal parts of the former are the cutoff wall, deck, crest, curtain, the supporting buttresses, and the bulkhead.

The deck is the water barrier extending from the heel at the base to the crest or rollway at the top of the dam. The cutoff wall is set into the bed rock or ledge at the heel so as to prevent leakage under the dam, and to provide additional anchorage.

The curtain is the part just below the crest on the down-stream side. Its surface is of such form as to direct the fall of water and ice away from the foot of the dam. The supporting buttresses are usually spaced from 12 to 15 ft. apart and braced, when the height is sufficient to warrant, by transverse reinforced concrete beams.

The bulkheads are formed by extending the inshore portions of the deck well above the floor level and building up the buttresses to correspond.

The deck, crest and curtain are usually reinforced by corrugated or twisted steel bars imbedded near the inner surfaces and spanning the buttresses. The buttresses are similarly reinforced, the bars passing through the concrete in various directions into the deck, crest, and curtain, binding the entire structure securely together. For this very reason cracks of varying depth and intervals, which are always present in massive concrete, are never found when proper reinforcement is used. The effect of the steel rods is to distribute the stresses throughout the mass instead of allowing them to concentrate at the weakest point.

The concrete for the deck, rollway and curtain is made very dense, the usual mixture being 1 part cement and 2 parts of sand to 4 parts small stone laid very wet. In cold climates, the crest and adjacent part of the deck are heavily reinforced in thickness on account of the severe ice conditions.

In dams of this type of construction openings are provided in the buttresses for one or more passage ways underneath the rollway so that the dam may be inspected from beneath while water is passing over the crest. This passage also serves as a ready means of reaching either side of the river.

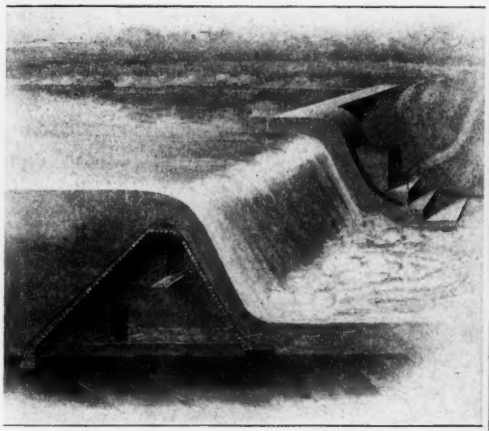


FIG. 2. CLOSED FRONT APRON DAM FOR ROCK FOUNDATION AND HIGH HEAD

FIG. 3. DAM AT SHELDON SPRINGS, VT., WITH CREST 3 FT. THICK ON ACCOUNT OF HEAVY FLOW OF LARGE ICE CAKES IN SPRING

A dam of this description shown in Fig. 3 was recently built at Sheldon Springs, Vermont. It is 270 ft. long with a mid-channel height of 40 ft. This dam is especially designed to withstand heavy ice gorges, which have carried out 3 dams at this point within 10 yr.

ONE OF THE NATURAL WONDERS of the country is the Giant Springs, located near the Great Falls of the Missouri in North Central Montana. This is about 3 miles below the town of Great Falls, the water rising through large joints in a sandstone rock on the bank of the river at the water's edge. The amount of flow is estimated at 638 cu. ft. a second, or more than 400,000,000 gal. in 24 hr. The water boils up with considerable force, is clear and with no dissolved salts of any consequence, it has a temperature of about 50 deg. F.

GAS ENGINES AND PRODUCERS

DU BOIS GAS ENGINES AND PRODUCER GAS PLANTS

STARTING with the four-stroke cycle, single-acting principle which 48 yr. of continuous testing and experimenting have shown to be the most practical and economical method of operation, the DuBois system of engines has been designed, incorporating many late improvements, using the center crank system and providing arrangements with 1, 2 or 4 cylinders to meet conditions of service.

In any engine, the main frame is the foundation of the whole construction. In the engine under consideration, cylinders and distance pieces are fitted together with circular neck and concentric recesses, each cylinder resting on a pedestal which is bolted to the bed plate, Fig. 1.

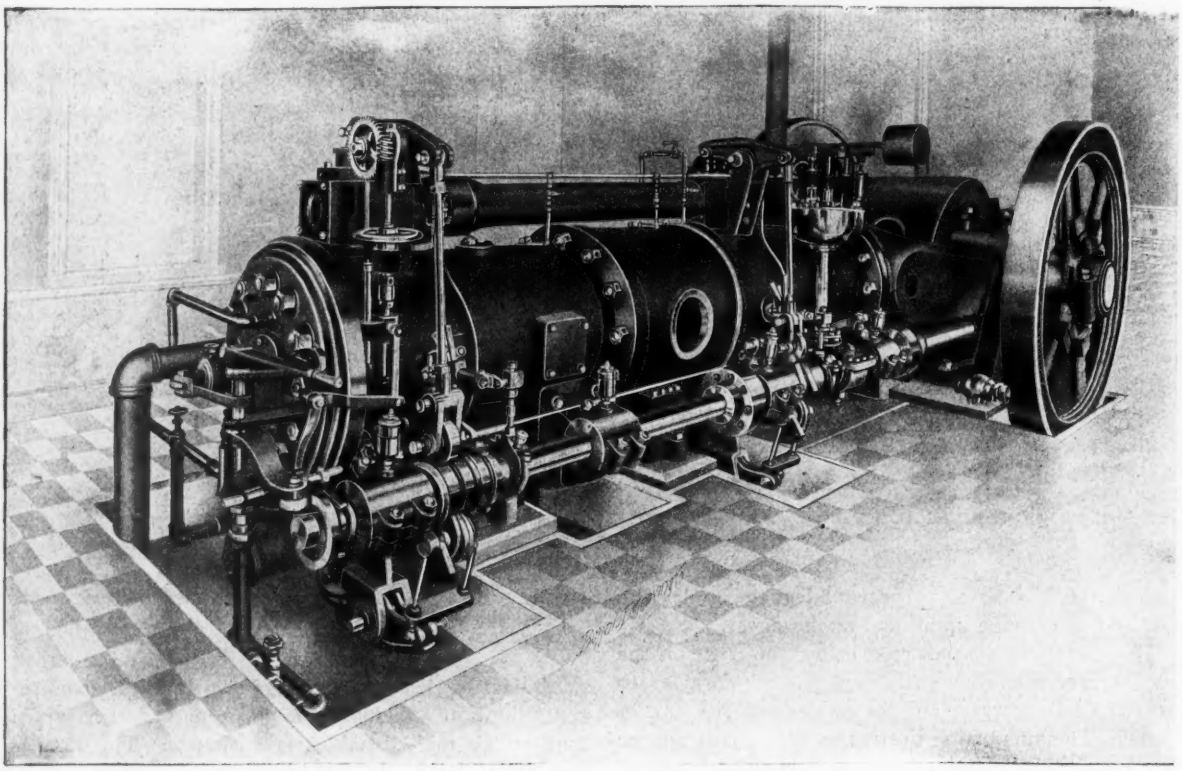


FIG. 1. DU BOIS TANDEM ENGINE

Bearings

In small engines, the bearings have 2 liners, easily removable, 1 in the bottom box and 1 in the top, which can be reversed, thus giving practically 2 bearings. In larger horsepowers, the main journals have quartered boxes, adjustable by means of wedges and which can be removed and renewed by raising the shaft 0.5 in.

Cylinders

Cylinder barrels and water jackets are cast in 1 piece, the water compartment being divided by 4 longitudinal ribs, so designed as to allow free expansion immediately surrounding the end of each cylinder where the explosion takes place.

Crank shaft, cheeks and pin are made in 1 piece of a solid steel forging with balancing weights bolted on to the heels of the cranks. Connecting rods are made of solid steel forgings with ends split and bolted together as in marine engine practice. The box for the crankpin is of genuine babbit, made as a removable liner and the piston pin bearing is of bronze.

Piston and Rod

Figure 2 which is a longitudinal cross section shows the internal construction of the engine and the unusual method used for packing the piston rod where it passes through the head end of the front cylinder. Packing rings are put on the rod similar to those used on the piston and these slide back and forth with the rod inside a sleeve which is contained in the cylinder head and in its rearward extension. The pistons are of trunk type, each fitted with 4 cast-iron snap rings. That part of the piston which is exposed to the explosion is designed with a convex head which prevents such expansion of the piston as would freeze it to the

cylinder. It also gives a lighter piston for a given strength than with the flat head.

Valve Gear

Figure 3 shows the form of the simple poppet valves of forged steel with beveled seats which are used in the DuBois engines. These are opened by 2 push rods and 4 rocker arms actuated by cams on the lay shaft. The valve rods are threaded right and left hand to allow of adjustment for natural wear, which can be made while the engine is running. Roller contacts take the thrust of the cam and deliver the motion of the rocker arm to the valve stem. Cages which are independent of the cylinder are provided for the valves so that, when regrinding or for necessary inspection, the entire valve mechanism may be taken away from the cylinder without loss of time. The proportion of gas to air is adjusted by hand, by means of valves in supply passages, 1 6-in. valve serving both cylinders. In the mixing valve, the stem carries 2 pistons the upper one of which controls the air supply by varying the space between its upper edge and the top of the cage, while the lower one varies the gas supply by means of ports in its wall and corresponding ports in the walls of its cage. Fig. 4 is a cross section through the cylinder showing the mixing valve chamber and the governor.

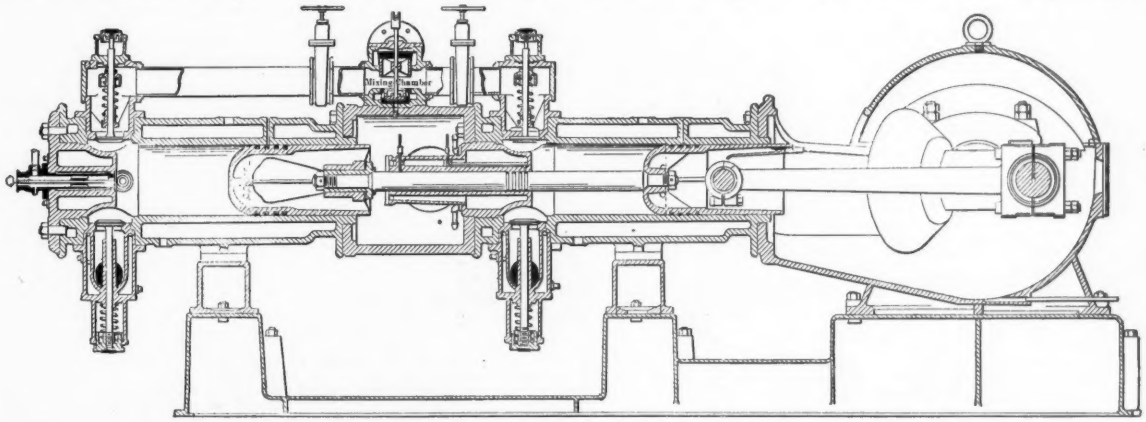


FIG. 2. LONGITUDINAL SECTION OF 2-CYLINDER TANDEM DU BOIS ENGINE

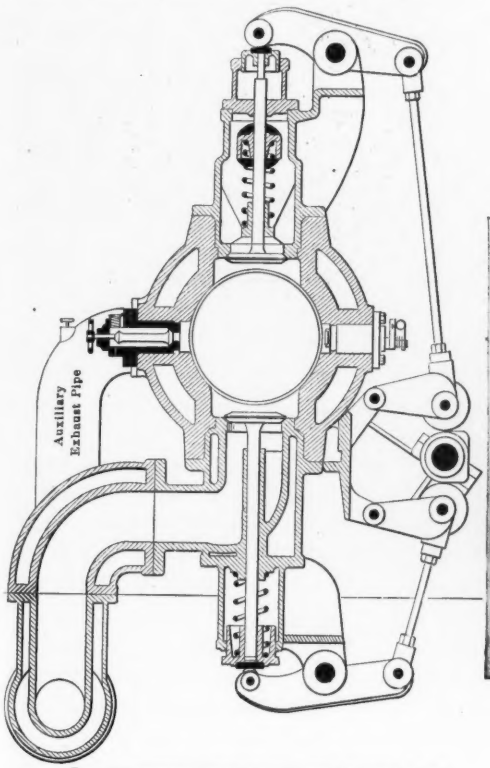


FIG. 3. SECTION THROUGH CYLINDER AND VALVE CHAMBERS

A valuable feature found on the DuBois engine and which has been used for 10 yr. with pronounced success is the auxiliary exhaust shown in Fig. 3. This consists of a series of round holes drilled through a rib which connects the water jacket wall to the cylinder barrel, the holes being drilled instead of cored in order to get absolute accuracy.

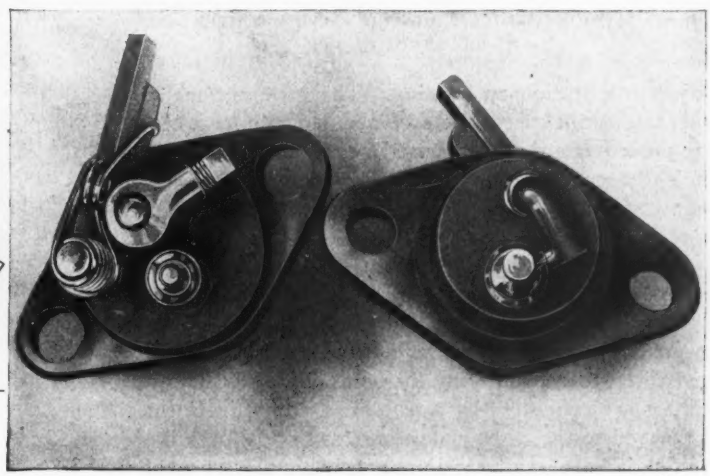


FIG. 6. MAKE-AND-BREAK IGNITER DEVICE

These openings are not uncovered until the charge burning in the cylinder has expended all its energy and the piston has completed the forward expansion

stroke. As soon as the auxiliary port is uncovered, the greater percentage of the exploded gases escapes to the muffler, the remaining dead gases being discharged through the main exhaust valve. This avoids passing all the gases and flame through the main exhaust valve thus avoiding the warping, burning and pitting of these valves, a condition which largely reduces the power of the engine because of leaks in the exhaust valve and also increases the fuel consumption.

Governor

As shown in Fig. 4 and 5, this is of the fly-ball type, having a spindle driven through cut spiral gears from the lay shaft, and the balls and sliding member enclosed in a stationary housing. The governor maintains a constant speed, but provision is made for a certain percentage of speed variation by hand adjustment, while the engine is running. This adjustment is in plain sight and accessible without danger to the operating engineer.

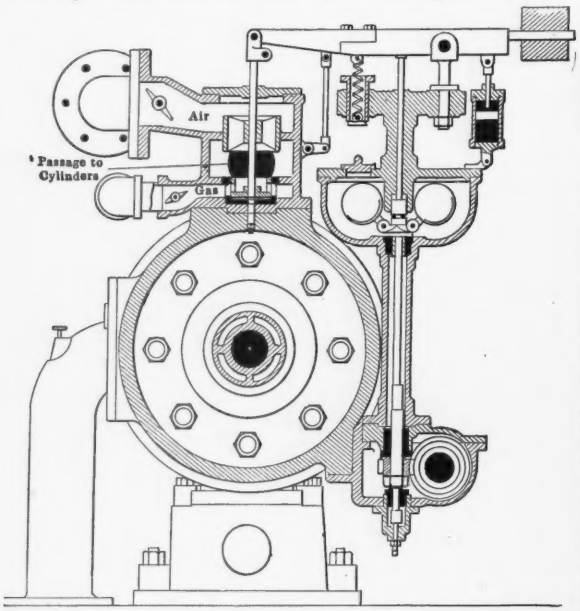


FIG. 4. SECTION THROUGH MIXING VALVE CHAMBER AND GOVERNOR

Ignition is accomplished by make-and-break mechanism, as shown in Fig. 6, the timing being accomplished by a handle near each cylinder. This raises or lowers a horizontal finger with bent end which trips the igniter, thereby altering the point of ignition. Both igniters are connected by a reach rod, and adjustment of this rod to the right or left retards or advances the timing of both igniters simultaneously, a feature of special advantage when starting the engine.

Provision has been made in 2 places for taking up natural wear; by adjusting the distance between the inside igniter hammer and stationary electrode, and also by taking up wear on the outside parts, such as springs and bell crank.

Oiling may be by a central gravity feed system, or with individual oil cups. Since the piston trunks are more than full stroke length, they always cover the oil holes in the cylinder walls so that timed lubrication is unnecessary, although the force feed oiling system is provided for the cylinders and intermediate head.

For starting with compressed air, the engine is equipped with a valve in the head of the rear cylinder, and the valve disk is located at the inner face of the cylinder head, so that when it is closed no pocket is formed in the combustion chamber wall, Fig. 2.

Figure 3 shows the water-jacketed exhaust pipe. Another feature is the injection of cooling water into the exhaust pipe, which cools the exhaust gases so suddenly that the final discharge into the atmosphere is noiseless.

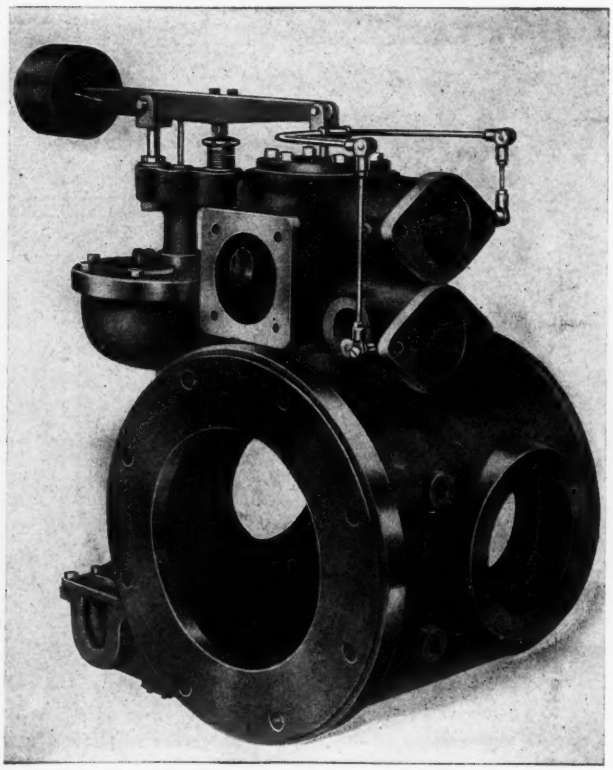


FIG. 5. GENERAL VIEW OF GOVERNOR

The water jacket around the exhaust pipe is chiefly for the purpose of avoiding dangerously hot surfaces where attendants are likely to come in contact with them.

The Producer

This is of the automatic suction type, in which the gas is produced as determined by the suction action of the engine according to its load.

Air for the combustion and gasification of the fuel in the producer enters the latter near its bottom, already warmed to a temperature proportioned to suit the conditions. The air is also saturated with moisture before it enters beneath the grate. The grates are usually the plain horizontal type as used in ordinary

boiler furnaces and are easy to attend, although mechanical operating or shaking devices are provided when advisable.

The producer is contained in an inner shell resembling a boiler shell, and lined with the finest quality of fire brick, the top of the producer being protected from the intense heat of the inside fire by arch bricks, which prevent damage to the upper part. The coal feeding apparatus is simple, consisting merely of the upper seal, the middle bell and the lower magazine.

Immediately surrounding the base of the coal hopper is provided a series of poke holes through which the fire may be poked as required. These poke holes are arranged with independent bushings having ground seats, into which ball covers, having holes running

jecting ribs, over which water is permitted to flow in such quantity as needed.

The gases flowing through the vaporizer impart sufficient heat to the projecting ribs to heat the water and generate steam which is carried with the circulating air, present in and around the vaporizer, to the base of the producer and disseminated above and below the fire grate. Further, the air in passing around the vaporizer takes up the heat from the gases, thus causing a direct saving of the sensible heat of these gases, which would otherwise be carried on to and lost in the scrubber.

Scrubber and Purifier

The scrubber is a cylindrical shell, similar in con-

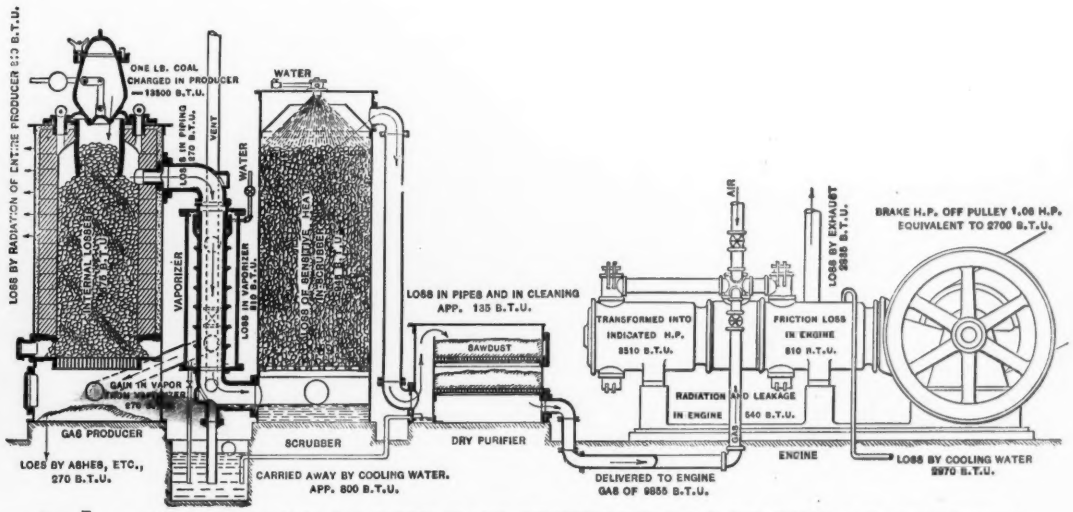

LOSS BY RADIATION OF ENTIRE PRODUCER 823 B.T.U.
ONE LB. COAL CHARGED IN PRODUCER — 13800 B.T.U.
WATER
LOSS IN PIPING 270 B.T.U.
VENT
WATER
INTERNAL LOSSES 1350 B.T.U.
VAPORIZER
LOSS IN VAPORIZER 810 B.T.U.
LOSS OF SENSIBLE HEAT IN SCRUBBER 1215 B.T.U.
LOSS IN PIPES AND IN CLEANING APP. 135 B.T.U.
SAWDUST
AIR
LOSS BY EXHAUST 2835 B.T.U.
BRAKE H.P. OFF PULLEY 1.06 H.P. EQUIVALENT TO 2700 B.T.U.
TRANSFORMED INTO INDICATED H.P. 8510 B.T.U.
FRICTION LOSS IN ENGINE 810 B.T.U.
GAIN IN VAPOR FROM VAPORIZER 270 B.T.U.
RADIATION AND LEAKAGE IN ENGINE 540 B.T.U.
GAS PRODUCER
SCRUBBER
DRY PURIFIER
ENGINE
LOSS BY ASHES, ETC., 270 B.T.U.
CARRIED AWAY BY COOLING WATER. APP. 800 B.T.U.
DELIVERED TO ENGINE GAS OF 9855 B.T.U.
LOSS BY COOLING WATER 2970 B.T.U.

FIG. 7. A COMPLETE DU BOIS GAS POWER PLANT, SHOWING THE HEAT EVOLUTION AND DISTRIBUTION

through their center, are fitted. The holes in the ball covers are made to correspond with the poking iron, so that during the process of poking, no quantity of gas can escape nor air leak into the gas pipes.

These balls are fitted with springs that insure a perfect seal when closed, and are also designed with a yoke so that they can be easily turned when the producer requires poking.

The construction of the producer is such that during the poking, cleaning or shaking down of grates, there is no interruption to the continuous evolution of gas in the producer.

Vaporizer

From the producer where the gas is generated it passes, Fig. 7, to the vaporizer, which consists of a circular tank, placed between the producer and the scrubber on the larger sizes, and inside of producer for smaller types. The heated gases coming from the producer flow straight through the vaporizer to the lower end of the scrubber.

As shown in the illustration the vaporizer is designed with an inside compartment, through which the gas flows to the scrubber. It is constructed with pro-

struction to that of the producer, and is filled with coke, over which a continuous spray of water is fed. Gases entering at the base of the scrubber and discharging from the top into the dry scrubber, receive a thorough scouring, which removes every particle of foreign substance, leaving them free and clean for utilization in the engine.

The main feature in the scrubber construction is the water sprinkler, and this has been designed so that it can be removed and cleaned from deposits while the engine is running, without interfering in any way with the operation of the plant.

The purifier is filled with sawdust and intended to take up all moisture in the gas, which it does effectively.

In plants up to 150 hp. the engine takes the gas directly from the purifier, but in the larger sizes a special storage tank is supplied.

Figure 7 gives the thermal analysis of the heat supply, that lost at different points in the equipment, and the heat equivalent of the power realized at the engine, assuming the coal charge to have a heat value of 13,500 B. t. u. per pound.

"GAS ENGINE TROUBLES"

By H. W. Jones

TO the writer, the above heading acts as a red rag to a bull. Why was this ever started? Who started it? And, when? Did anyone ever see the same words coupled on to a steam engine or ever hear of Motor Troubles or Automobile Troubles, or Air Compressor Troubles? Whenever an engineer in a steam plant has trouble (and they certainly do have it) does he send out for a steam engine expert? No, he gets busy and rectifies the source of the error.

Did you ever see 3 to 10 men pulling on the flywheel or belt of a steam engine to start it; or, did you ever hear a man that owned a steam engine condemn the whole steam engine fraternity because his engine was no good? Does the engineer of the plant say to his employer "Didn't I tell you that steam engines were unreliable and often stopped out of pure cussedness?" Or, does he say: "Well, Mr. Employer, I told you when you bought this type, or this make, or this grade of engine, etc."

But gas engines are everlastingly lambasted because somebody in his ignorance bought an unknown engine and a worthless one at that, and one that even the expert from the factory can't make operate, and then, "gas engines are no good—they give trouble;" —they are unreliable. When in reality the "Simon Pure" truth of the matter is that it is ignorance coupled with blind prejudice that is the trouble.

Are we to understand that the reason a steam engine requires an engineer is because of the fact it never has trouble, or is he there to prevent trouble? In my experience I have seen an installing engineer show a buyer how to start a gas engine and then forget to turn on the oil, and only by a lucky chance save cutting out of the cylinder by the smell as he passed by the basement window on his way to the shop. And today in many catalogues, we read that our engines require no attention except oiling the bearings, cylinders, etc. Nothing said about the water cooling, and then we talk about "Gas Engine Troubles."

I saw an installing engineer—a man who had his card printed with the words "Gas Engine Expert" on them,—I saw this man install an engine in a shed and connect it to city water, yet he left absolutely no way to drain the cylinder jacket to prevent freezing. And this engine froze up the third night after it was installed, and the engine was guaranteed against defective material and "workmanship." The owner stood suit on the matter and won his case, but he blamed gas engines, and yet we talk of gas engine troubles.

I have seen a gas engine being operated on city gas with the graduated scale cock 38.5 in. away from the intake valve, and a suction opening intake at that, and yet we talk of gas engine troubles. I have seen a gasoline engine operating a cement block machine, which took full power of the engine to run and the engine was cooled by a tank of water and the "expert" was running it with the water in the tank 6 in. below the return pipe. I have seen an engine set on wood timbers 12 by 12 in., one timber 5/8 in. lower than the other at the crank end; and these timbers were bolted down solid and in order to level up the engine they had placed 3 old shingles under the low side.

Why, I set an engine myself on skids of 12 by 14 in. timbers, and bored the holes through the 12 in. way when I should have bored the 14 in. way and then I placed on top of these timbers 2 in. planks and put in 8 lag screws to hold the engine, a 35-hp. And when the 2-in. plank sheared off the lag screws and the engine slid off the "foundation" and pulled the shafting down with it, why, of course, "gas engine troubles" was blamed; but, I knew better. But did I tell my customer that it was my own fool-headed ignorance that nearly ruined his shop? Oh! yes; I fixed the foundation and he fixed his shafting, and I was honest 3 months after because I paid him for his shafting repairs. But think of the effect!

Gas engine experts are in many cases, what the father answered his little son, when he asked what a "diplomat" was, that it was "a trained liar."

"Horse sense," said a prominent horseman to me once,—"horse sense, why, there is no such thing. Horses haven't got any sense, etc." Now, this strikes me as applicable to gas engine makers, salesmen, owners and all really and truly interested parties, that we have no "sense" and plainly show it when we continue to allow gas engine trouble to be spoken of. It is not now, never was, and never will be that. It is ignorance, not gas engine ignorance, but human ignorance of the very worst type because it is criminal, positively criminal, for "he who steals my purse, steals trash, but he who steals my good name, etc.," and that is just what we do when we speak of "gas engine troubles." Then see printed in big black type, "Our engine needs no trained operator, a child can run it." Now, any man who tries to claim that a gas engine needs an engineer to run it, is ignorant. What gas engines require is someone who is competent to put and keep the engine in condition to run.

Whenever the ignition battery of a gas engine becomes exhausted, it is classed as "gas engine troubles," but when the dry battery controlling your door bell is exhausted is that "door bell troubles" and heralded and hawked around by the manufacturer of the old style knockers; or when the oil holes or cups controlling the main bearing get stopped up with dirt and the bearing heats and melts out the babbit, does this not prove conclusively that gas engines are unreliable and that gas engine troubles do exist?

I was out "experting" one day to find out why a certain engine, a 7-hp. vertical natural gas engine, would not work, and often would pound and stop. Well, I took off the head and took out from the top of the piston a full half pint (no exaggeration) of carbonized oil. No more trouble. The owner, a laundryman, said he was a mechanic and he knew the value of

oil. After he was shown, he realized far more than ever the value of oil. He uses less of it now. He has been convinced he really had underestimated its true worth.

And so it goes. But I want to say that "gas engine troubles" are like "horse sense;" "they don't be any sich thing." It is all ignorance and now that we are discovered for Heaven's sake let us admit it, plead guilty, promise to do better, and the next gas engine "expert" we hear talking of "gas engine troubles" let us lead him to some secluded spot and abate him.

REQUIREMENTS IN OPERATING GAS ENGINES

By John Meyerott

YOU no doubt remember the claims made by manufacturers of gas engines, when they were first placed on the market: No engineer needed, no trouble, no danger from explosions; any child that can fill an oil cup can care for and operate it, etc., but how different it all turned out.

I remember the first one that I helped install and operated more than a year. I was capable of taking charge of any steam plant as chief and in fact almost any kind of machinery I had seen; but this gas engine had me guessing a few days. I went on the theory of the manufacturers and at one time condemned the gas engine as a complete failure; but I began to investigate the trouble and found the cause, which was not the engine's fault, but the maker's fault.

In this engine the vaporizer was a very crude affair and the ignition arrangement was badly placed, which caused me much trouble. But at the present time we know more about gas engines and have this part of the equipment very satisfactory; yet it requires more than a fool to operate one successfully.

Timing

In the gas engine we have as much to understand as we do in the steam engine. The inlet valve must open and close at its proper time, and the exhaust valve must open and close at its proper time, and the ignition must take place at the proper time also. These times all vary somewhat with the speed and fuel used and can best be found by actual running trials.

The old theory of valve timing was: The inlet valve must open when the crank is passing inward center and remain open until the crank is on outward center; the inward stroke is the compression stroke and the charge should be ignited at the point of highest compression, which would be on the inward center of crank, then the expansion stroke is outward until the outward center of the crank is reached when the exhaust valve should begin to open and remain open until inward center is reached again. This was all right in theory, but in practice I have found it failed to give best results in economy.

The timing of the valves has been studied, and most makers have them so arranged, that they are practically correct. But for the benefit of those who might wish to know, I will give my plan of setting the valves. If the inlet valve is mechanically operated, it should open about the time the crank has traveled 10 deg. from back or inward center and remain open 180 deg. of the crank circle, the crank having traveled 190 deg. when compression begins.

The timing of the ignition is next and must be varied according to the fuel used. Gasoline of 70 or 72 gravity and gas rich in hydrogen burn more rapidly than the heavier oils or gases; therefore, the timing must be later than for distillate of 65 to 68 gravity. I will say for 68 gravity distillate the ignition should take place about 25 to 30 deg. below inward center. This can best be determined by trial, also regulating the fuel while adjusting the spark. The exhaust should open about 10 or 15 deg. before outward center of outward stroke and remain open until the crank travels 190 deg.

Many of you may not understand why the charge should be ignited before center is reached; for those I will say that it requires a certain length of time to burn the fuel, and this must all be burned before expansion begins in order to make best use of the heat.

Heavy Oils

The heavier oils and gases may be ignited 30 deg. before center, but then several things must be considered. Firing so early gives high temperatures, and if the engine is large, the center of the piston may get red hot and cause premature ignition, which is very objectionable. I have injected water with the fuel to keep down this temperature, with success. This high temperature makes lubrication a difficult problem.

If poor oil is used, that is, of low fire test, or carrying asphaltum, much trouble will be caused by the oil partly volatilizing and partly burning, causing carbon to form, which brings wear and many other troubles. Therefore, use none but the best of cylinder oil, and use enough, but not too much. I have seen exhaust pipes completely choked by using too much cylinder oil of pure quality.

Hunting the Snag

If you have an up-to-date engine, built by any of the leading makers and it fails to give satisfactory results, don't blame the engine; it is your fault, no doubt. You don't understand some point about it, and I would advise you to do as I did. First find if your engine has good compression; if not, find the cause. Turn the engine over slowly and see if the exhaust valve moves freely and seats properly; also examine the inlet valve the same way. If these are all right, put an extra supply of cylinder oil on the piston and if the trouble is there you can hear it, readily.

Never remove the cylinder head unless absolutely necessary. Withdraw the piston and examine the inside of the cylinder or piston rings any time, but leave the cylinder head alone. If compression is good you had better examine the battery and connections; be sure you have a good spark and at the right time. Go

over all connections frequently; keep the batteries in a box by themselves; never put tools, waste or wire in with them. Always be sure you have fuel in the supply tank and have it turned on when you intend to use it. I went 5 miles once to find what was the reason the engineer could not start his engine, turned on his fuel at the supply tank, and went home.

If you will study the principle of your engine, you will very soon be able to keep it in good running order and do good work, but remember that you don't know it all yourself and the other fellow may not know as much as you do.

After I had been around a gasoline engine 1 week I thought I knew all there was to be learned; now I have been around them for 9 years and I am learning everyday. There are many things I could tell to do in case of trouble, but it would only confuse you. The few rules I have here given will lead one right.

There are certain dangers to be guarded against, principally in starting the engine. First, be sure your spark is retarded so you do not get back firing. If you turn your engine over by hand with a crank or by flywheels, always stand so you will be free from wheels in case of back fire or being struck by starting crank.

Finally, a man who wishes to become an expert in gas engines, must understand the subjects of mechanics, heat and chemistry.

GAS ENGINE QUERIES

1. Will a 2-cycle gasoline engine give double the power of the same size 4-cycle engine?

2. How does advancing and moving back the spark govern the 2-cycle engine?

3. Does it waste fuel at low speeds?

4. Which requires the more air to burn properly, gasoline or kerosene?

5. I notice in gas engine catalogs the vast difference in weights; for instance, a 4-hp. weighing 850 lb. and a 10 hp. 400 lb. Is the high power and light weight all right?

6. I got instructions with a 4 hp. air cooled automobile engine not to run it 3 minutes without load, that it would get excessively hot. Why would it?

7. The engine has one cylinder, 3.25 by 3 in. stroke, 2 cycle; will it develop 4 hp. on gasoline, at a reasonable speed? G. D. R.

A.—A 2-cycle engine will give practically twice the indicated power of the same size 4-cycle, but from this must be subtracted, in getting the power delivered by the engine, that necessary to compress the mixture of air and gas before it enters the cylinder.

2. Governing any engine by changing the time of ignition is accomplished simply by making the spark come earlier or later in the stroke. An early spark increases the power and a late spark decreases it, with the exception that if the spark be made very early the explosion may come before the crank has passed dead center, in which case back firing is really produced, and this is not a desirable result.

3. The method of governing by changing the point of ignition wastes fuel at low power because the same amount of charge is taken in and burned, regardless of the time when ignition takes place, but with late ignition the power derived from this charge is less than with ignition at the normal time. For automobiles low speed means low load.

4. For gasoline, 1 lb. of the liquid requires 189 cu. ft. of air for perfect combustion, and for a pound of kerosene 190 cu. ft. of air are required for complete combustion. These values are, of course, liable to some variation with the quality of the fuel.

5. The power of an engine depends on its speed as well as its size, so that a slow-speed engine of 4 hp. might easily weigh 850 lb. and a high-speed of the automobile type, of 10 hp. might easily weigh 400 lb. The 4 hp. would probably be built to run at 400 or 500 revolutions, while the 10 hp. might run at 1,500. A high power and a light weight is a more expensive engine for a given power than if the greater weight were used, and is not so durable. The reason for the greater cost is that on account of high speed it must be made with better material and much more careful workmanship.

6. The reason for not running your automobile air-cooled engine without load is this: An automobile engine running without load is standing still. There is, therefore, no air passing over the cylinder of the engine to cool it. When the machine is going, the motion creates a wind over the cylinder, which carries away the excess of heat.

7. You do not state the speed of your engine and, of course, we cannot tell what speed it is supposed to run at without knowing the type of engine. For a marine engine of the size which you mention, running at 600 r. p. m., the horsepower developed would be about 1.25. In order to get 4 hp. out of it you would have to run it at about 2,000 r. p. m. If it is an automobile type of engine it will probably stand this.

GRAPHITE FOR ENGINE CYLINDERS

Experiments on this subject have been made by Walter M. Durand, who gives the results in The American Machinist. He used a 6-hp. horizontal gas engine, running on city gas, and finding it impossible to mix the graphite and oil and feed them through the ordinary lubricator, he tried feeding the graphite dry through the air intake, using also cylinder oil through the lubricator.

Experimenting with different amounts of graphite the best results were found when the engine was fed about 1/12 to 1/8 oz. per horsepower, in a 10-hr. run; the amount should be distributed as evenly as possible throughout the 10 hr. The experiment has continued for 4 months during which time the engine was given complete test, and at the time the report was made was in good condition. At the end of the fourth month the cylinder walls were found in fine condition, without a sign of a scratch.

HANDLING AN ICE PLANT

By J. O. Parker

WHEN an engineer who has never had any experience in a refrigerating or ice plant starts to running in an ice plant he must depend on information from others until he can get things straightened out himself as to the best way to operate the plant economically. All books do not go into detail and explain just why certain things must be done to operate the plant successfully, and I would like to write here some of the things I would like to have known at the start.

Pressures

The most economy is gained in handling the suction and condensing pressures by having as little difference between the two as you can; that is, carry a high suction pressure and a low condensing pressure. The lower the condensing pressure the less work the engine will have to do to discharge the ammonia gas into the condenser, and the cooler the liquid ammonia will be when leaving the condenser.

One authority says that with a condensing pressure of 185 lb., with the liquid ammonia leaving the condenser with a corresponding temperature of 95 deg., if cooled to a temperature of 65 deg., will effect a gain of 65 per cent. I believe it would cost as much to lower the temperature as the saving would be, and it seems as if it would be possible to make the saving without excessive cost of more apparatus to effect it.

While it is more economical to operate with a high suction pressure, that pressure will depend on the temperature of the brine tanks and storage rooms. A pressure should be carried corresponding to the boiling point of ammonia of about 10 deg. below the lowest temperature to be handled. With a higher suction pressure, the ammonia compressor will displace more gas, handling more ammonia in the refrigerator and doing more refrigerating. The loss due to the expansion of the gas in the clearance space is less and this will also insure a more positive working of the suction valves in the compressor, allowing the cylinder more nearly to fill with gas during the suction stroke.

There is more economy in pumping dry gas in a compressor than wet gas as it requires the evaporation of more liquid ammonia than is necessary to do the refrigeration to keep the compressor cool. The loss due to the re-expansion of the wet gas in the clearance space must be considerable; it also keeps the compressor so cold as to freeze the piston rod packing, and this will have to be pulled so tight to prevent leakage that its life will be short and cause the rod to wear very fast.

Packing

The piston-rod packing in a double-acting compressor is more complicated and requires more attention than that of a single-acting compressor as part of the packing has to hold the high pressure. The stuffing boxes on double-acting compressors have iron lanterns placed between the sections of packing, the lanterns opening to a pipe running from the stuffing box into the suction pipe of the compressor so that the gas leaking past the packing may pass into the cylinder. Thus the packing nearer the packing gland is only subject to the suction pressure, but if care is not taken to keep the packing tight, the loss due to pumping the escaped gas over again will be considerable.

Packing glands are usually constructed so that oil may be pumped through the gland and around the piston rod to insure good lubrication. Care should be taken, when handling dry gas, that the packing is not too loose, as the packing will work through the lantern and pipe and be carried into the system with the leaked gas. The oil will disappear in the same manner, and unless you keep the oil drained out of the oil intercepter, there will be too much oil through the system. The packing can be kept up snug in the stuffing box in handling dry gas to prevent leaking, and not burn the packing or score the piston rod for the packing will stand more heat than the oil.

Condenser

In a can ice-making plant the quality of the ice depends on working of the distiled water apparatus. If the refrigerating part of a plant operates economically the exhaust steam from the engines, pumps and auxiliaries is not sufficient to make water enough to fill the freezing cans. To make up the deficiency when more water is required, live steam can be put in the steam condenser or exhaust steam may be shut off the feed water heater and an injector, if one is installed, used to furnish hot boiler feed water. I have found it a good plan to lower the live steam pressure, as the engines working on a lower pressure will use a larger volume of steam and more water can be had.

The steam condenser should be kept free from scale as possible. One-eighth of an inch of scale on its surface would probably lower its efficiency 10 to 15 per cent. Too much condensing water should not be allowed to run over the steam condenser, as it will condense all the steam, form a partial vacuum inside, and draw the cooling water through any small leaks that may be in the condenser and spoil the ice. Then, too, if the distilled water leaving the condenser is below the boiling point, it will require more steam to be used in the reboiler to raise its temperature to the boiling point again.

Reboiler

The reboiler is a very important factor in the plant as it is depended upon to work all the air and foreign gases out of the water to make the ice clear. The

cylinder oil carried with the steam and water as far as the reboiler is allowed to come to the surface and is "skimmed" off by keeping the reboiler full and running over just enough to carry the oil away. Reboiling the water too hard causes too much agitation, retarding the separation of the oil and other impurities from the water, and allows too much of the water to pass off in vapor.

Water passes from the reboiler, through pipe coolers (or flat coolers), filters and storage tank (the suction pipe from the expansion coils to the compressor passes through it), to the can fillers. The water on its way down should flow by gravity, the pipes being perfectly tight, and its temperature lowered to as near the freezing point as possible, making just that much less work to be done in the freezing tank.

REFRIGERATION

TEMPERATURES AND MACHINE RATINGS

By Charles L. Hubbard

IN ACTUAL operation, the relation of temperatures and pressures should receive the most careful attention of the engineer, because a compression pressure which is much higher than required by the prevailing temperature of the cooling water passing over the condenser causes a waste of power, and on the other hand, an evaporating pressure in the vaporizing coils which is not sufficiently low, does not absorb as much heat from the brine or from the air of the "cold room" as it should.

Cooling Water and Compression

The temperature of the cooling water determines to what pressure the ammonia gas shall be compressed in order that it may be liquified in the condenser. For example: When the temperature of the cooling water is about 70 deg., the condenser pressure in the ammonia system should not be less than 150 lb. gage pressure, and with higher temperatures for the cooling water the pressure must be increased correspondingly. At 60 deg., the pressure should not exceed 125 to 130 lb., and with deep-well water of about 55 deg., a condenser pressure of 105 to 110 lb. will be found sufficient.

Brine Temperature

The temperature to which the brine or other refrigerant is cooled will depend somewhat on circumstances. In ordinary cold-storage work this may be taken as an average of 15 deg. above zero. In order to maintain this temperature, the temperature of the ammonia gas should be about 10 deg. lower, which corresponds to a gage pressure of 19.5 lb. per square inch. Table I will be found useful for determining the pressures required for different degrees of cooling.

TABLE I. PROPERTIES OF SATURATED AMMONIA

TEMPERATURE DEGREES F.	GAGE PRESSURE	LATENT HEAT	VOLUME IN CU. FT. OF 1 LB. OF VAPOR
−40	−4	579.7	24.38
−35	−2.4	576.7	21.32
−30	−0.6	573.7	18.69
−25	+1.5	570.7	16.44
−20	3.7	567.7	14.48
−15	6.3	564.6	12.81
−10	9.1	561.6	11.36
−5	12.9	558.6	9.89
0	15.7	555.5	9.14
+5	19.5	552.4	8.04
10	23.8	549.3	7.20
15	28.2	546.3	6.46
20	33.2	543.1	5.82

For example: If it was desired to maintain a temperature of 30 deg. in a cold-storage room, the temperature of the ammonia vapor should be 30 — 10 = 20 deg., which from Table I corresponds to an evaporating or suction pressure of 33.2 lb.; or in an ice-making plant where the cooling surface is such that the brine must be circulated at a temperature of 5 deg. above zero, the suction pressure should be 12.9 lb. The use of the other figures in Table I will be shown later in determining the size of compressor.

Rating of Machines

Machines are usually rated in tons of refrigeration or refrigerating effect in 24 hr.; that is, the equivalent of so many tons of ice at 32 deg. melted into water at the same temperature. This is equivalent to the absorption of 2,000 × 142 = 284,000 heat units per ton of refrigeration, 142 being the latent of water at 32 deg. The actual ice-making capacity of a machine is much less than its refrigerating effect owing partly to the necessity of first cooling the water to the freezing point and also to the various losses in handling and other parts of its manufacture. It is customary in practice to consider the actual ice-making capacity of machine equal to approximately 0.5 its refrigerating capacity.

Size of Apparatus

The different parts of a refrigerating apparatus must have a certain relation to each other the same as in a power plant.

These can be computed for different conditions if desired, but for the purpose of the present article it seems best to give average proportions as commonly used in practice.

Evaporator

We have seen that 1 ton of refrigeration represents the transfer of 284,000 heat units from the brine to the ammonia, hence the surface must be sufficient to transfer this amount of heat under the temperature differences commonly employed.

In the case of a brine tank system where the brine is to be cooled to a temperature of 15 deg., from 40 to 50 sq. ft. of cooling surface should be provided in the coil. Taking the higher figure for safety, this would call for 150 linear ft. of 1-in. pipe, 115 ft. of 1¼-in. pipe, 100 ft. of 1½-in. pipe or 80 ft. of 2-in. pipe for each ton of refrigerating capacity.

The tank itself should contain on an average about 50 cu. ft. of storage space per ton. If a cooler of the enclosed-shell type is used, about 12 sq. ft. of coil sur-

face should be provided per ton of refrigeration, which in round numbers is equivalent to 36 linear ft. of 1-in. pipe, 28 ft. of 1¼-in. pipe, 25 ft. of 1½-in. pipe, or 19 ft. of 2-in. pipe. The shell is made only large enough to accommodate the coils easily, as there is no advantage to be gained by a larger space.

Condenser

For the atmospheric condenser, about 30 sq. ft. of external pipe surface per ton capacity is commonly used for cooling water of average quantity having a temperature of 60 deg. For the submerged type, the surface should be increased to 35 sq. ft. These amounts can easily be reduced to linear feet of pipe of different sizes as above.

The double-pipe condenser as commonly rated has 7 sq. ft. of external pipe surface for the inner or water circulating surface, and 10 sq. ft. for the outer pipe, which corresponds to approximately 20 linear ft. each of 1¼-in. and 2-in. pipe. These are also based on a temperature of 60 deg. for the cooling water.

Compressor

We have seen that each ton of refrigeration requires the absorption of 284,000 heat units in each 24 hr., or $\frac{284{,}000}{24 \times 60} = 200$ heat units a minute, in round numbers. Assuming a brine temperature of 15 deg. and a temperature 10 deg. lower, or 5 deg. in the evaporator, we find from Table I that the latent heat of ammonia at this temperature is 552 B. t. u., which means that 552 heat units are taken up by each pound of ammonia when it is vaporized. From this it is evident that $\frac{200}{552} = 0.36$ lb. of ammonia must be vaporized a minute for each ton capacity of the machine. Table I also shows that 1 lb. of ammonia gas at a temperature of 5 deg. has a volume of 8 cu. ft., so that in the present case $0.36 \times 8 = 2.88$ cu. ft. of gas must be compressed for each ton rating of the compressor. This in round numbers is 5,000 cu. in. In practice, this is increased somewhat to allow for the various losses, allowance being 5,000 cu. in. of gas for a brine temperature of 28 deg., 7,000 cu. in. for 15 deg., and 9,000 cu. in. for 0 deg.

Example: A double-acting compressor having a cylinder 12 in. in diameter has a piston area of 113.1 sq. in., and with a 30-in. stroke, operating at 60 r. p. m. (120 strokes), would have a capacity of $113.1 \times 30 \times 120 = 407{,}160$ cu. in. of gas per minute.

This compressor would have the following rating in tons of refrigerating effect in 24 hr.:

Temperature brine 28 deg. $\frac{407{,}160}{5000} = 81$ tons

Temperature brine 15 deg. $\frac{407{,}160}{7000} = 58$ tons

Temperature brine 0 deg. $\frac{407{,}160}{9000} = 45$ tons

These results are only approximate, but are based on actual practice under average conditions.

WITH THE NIGHT SHIFT

It was about 10:30 of a summer evening and everything about the refrigerating plant was jogging merrily along when without warning the compressor engine began to slow down and came to a definite stop. The watch engineer, noticing the slowing down and knowing that everything had been running all right up to this time, guessed that the disk on the stop valve, which controlled the speed of the engine, had become loose, and running to the boiler room door told the fireman to shut off the stop valve on No. 2.

Mr. Fireman, thinking of the downy bed in which he wasn't and avoiding the use of such common sense as he ordinarily carried with him, closed the stop valve on No. 2 boiler, whereas the watch engineer had meant that he should close the valve to No. 2 engine. The furnace under No. 2 boiler was throbbing under the impetus of a heavy fire, and as some one had neglected to try the safety valves that day they were stuck fast and the pressure went up 30 lb. before they opened. The noise was something terriffic and those 3 firemen were scared so badly that the boiler room was left to take care of itself while they scudded for safety.

When the gang came down to earth again and it was seen that the roof was still on the plant, they slunk back to the boiler room and cut the boiler in on the line. The watch engineer shut off No. 2 engine and taking off the bonnet of the throttle valve took the disk out, but the problem then was how to start up the engine with load on it.

I came on watch at 11 o'clock and things were still sizzling, and stayed so until about 1 o'clock when I was sent out in the rural district to get the chief to come down and straighten things out. He came in about 2:45, ordered the stem and bonnet put back into the throttle without the disk and had the engine going in 15 min.

The stop valve which controlled the engine was in a separate room where the engine could not be seen. The chief sat on the edge of a table calmly swinging his legs giving orders, with 2 men working the ammonia valves on the engine, while I was stationed in the boiler room door to repeat orders to the man stationed at the stop valve outside. I have often seen one engineer work half an hour to get one of the big compressor engines over the center when he had a globe throttle valve right by the engine to help out; but the chief started this one with an ordinary 8-in. gate valve which has to be opened a number of turns before any amount of steam will pass through, and then it goes with a rush.

What I am wondering is how he had courage to start a big engine the way he started that and get load on the engine and steam on it at the same time.

George Quinton.

FOR STEAM TURBINE INSTALLATIONS a condenser cooling surface of 4 sq. ft. per kilowatt is common in good practice.

STEAM TURBINE THEORY AND DESIGN

By Joseph H. Hart

STEAM turbines differ very little in actual theory and operation from the ordinary developments for the utilization of hydraulic power, the complexities which have arisen being due chiefly to the enormous velocity of the operating fluid and the necessity of constructing machines to operate efficiently at these high velocities. The complication of the subject by the introduction of thermodynamic formulas and special terms used in this connection, while extremely satisfactory and efficient from the standpoint of actual calculation of design and efficiency, are not necessary for a clear physical understanding of what takes place in the modern steam turbine, and why these units are constructed as they are, and what factors enter to limit their efficiency of operation.

Undoubtedly the turbine development is apt to extend into a number of other fields. There is no special reason why compressed air turbines should not operate on an efficiency at least equivalent to that of the reciprocating engine, and the possibility of utilizing some such form of prime mover to obtain power from the expansive force of carbon dioxide gas presents possibilities in the utilization of this latter substance as an agent in the transformation of power never before considered and one which offers possibilities of greatly increased efficiency in this development.

Low pressure turbines are steadily becoming more common and their theory and design are based upon the same fundamental principles as those in the high pressure unit, and their field of utilization is much more widely extended. The possible commercial development of some form of gas turbine is also dependent upon conditions existing in accordance with the same fundamental theories, and the difficulties to be met with in this field, and the ever-present limitations on its commercial development, are at once understood from a clear physical conception of the steam turbine theory, which can be obtained practically without the use of formula or mathematics at all, and which, when acquired, will undoubtedly help in a clearer understanding of the mathematical development obtained and the beauty and efficiency existing in the latter.

Kinetic Energy of Gases

A clear understanding of the operation of the steam turbine and the important factors in its development can only be obtained by a more or less clear fundamental conception in regard to the kinetic theory of gases. According to this theory a gas consists of molecules moving around like little bullets in space, more or less free from the influence of one another, but free to exert pressure by collision or impact, and consisting of a number of elastic bodies, as far as the absorption of internal energy is concerned. The pressure on the piston of an ordinary steam engine is due to the multitudinous impact of these small particles, the sum of the small forces exerted by each colliding unit being what is known as the ordinary pressure of the gas.

High pressure steam is no exception to this general condition existing in gases and is of interest only on account of the ease of production and comparatively heavy weight of each individual molecule or projectile, and on account of the further limitations due to its high boiling point and the effect of the latter's close proximity to the liquid state in the behavior of this material in its gaseous form.

An additional complication arises in the mind of the average engineer in the utilization of the energy in this form in the steam turbine owing to the often absolute interchangeability of the available energy with the so-called temperature of the gas. The exact physical significance of temperature in a gas is unknown, but it is known to be within certain limits more or less proportional to the mean kinetic of the individual projectiles or molecules and the constant of proportionality between these two has been defined as the entropy.

Expansion and Velocity

Comparatively no work is done by a gas in expansion into a vacuum. The direction of movement of the molecules alone is changed and this change consists simply in an ultimate directed movement of the molecules toward the vacuum rather than the helter-skelter movement at random in the mass of the gas. This process is called transforming the heat energy of the steam into kinetic energy of motion but, in reality, the kinetic energy of motion was present, and it has merely been a sifting process in the first place followed by a resifting, which goes on indefinitely as the molecules gradually line up in this direction. In actual practice the mass of the steam, consisting of a large number of molecules, appears to go faster and faster as it emerges from the orifice and travels around the pipe.

So-called eddies in this fluid result in temperature and entropy changes in the gas and limit in turn the efficiency of transformation of the kinetic energy of motion in the same way. In actual practice an important difference arises in the utilization of this kinetic energy of motion in comparison with that involved in the utilization of this form of energy in other materials. The speed of the gas molecules is such that it is only with extreme difficulty that the energy can be caught on moving vanes and transferred to them.

In the water turbine the difficulty is all the other way. The flowing water strikes the turbine and imparts its energy to it, but the speed of the wheel can be so increased by this means that a portion of the moving vane may, in turn, push on a portion of the

moving water which is slowed up and return a portion of the energy to it. In steam turbine practice seldom, if ever, has the speed of the moving parts even approached the most efficient condition, let alone exceeding it. This energy is transferred most efficiently from a moving fluid to a vane, as in the case of the water wheel, when the speed of the vane is just ½ that of the moving fluid.

Fundamentals of Design

In regard to actual design in steam turbine operation, the important points are based upon a few fundamental conceptions. The so-called entropy or constant of proportionality, dependent upon a number of factors, and affecting, as it does in actual practice, the amount of available energy obtainable from the gas, presents certain important features which must be considered.

The shape of the nozzle by which the steam is injected in the turbine is dependent upon ordinary conditions of flow of a fluid and impact collisions and eddies as well. The construction of a passage for the latter, if properly designed, will result in increased speed of the molecules or of the steam, with consequent great rise in temperature if stopped in precisely the way an ordinary liquid would act in these circumstances. The shape of the vanes, both radiatory and resistant, are constructed so as to allow easy flow or rebound without interference of the moving molecules with those following. Turbines can, like water wheels, be constructed along various designs.

The flow of the material may be along the axis of the turbine with a peripheral component alone or a radial one as well. It may be peripheral in flow simply or peripheral and radial as well. It may in reality exist in almost any combination of these 3 components, dependent upon the design of the entire machine in all its parts, and in general conditions hold here similarly to those existing in water wheel design and practice with the one limitation of a reversal in effect of varying changes in speed. Undoubtedly the axial flow turbine seems the one today that has attained the chief practical development, although its combination with a radial and peripheral one exists in some units.

In precisely the manner in which water loses its velocity in passing through a turbine, the steam does so as well, and requires an enlargement of the passage to prevent congestion for reasons precisely similar to those that exist in water turbines. One of the chief difficulties formerly met with in early turbine design was due to the existence of the so-called end thrust. This latter, as in ordinary water turbine operation, or in that of an ordinary screw propeller, is large and has been satisfactorily solved by the axial coupling up of 2 turbines in a single unit, in which the axial components are counterbalanced, or by the construction of suitable pressure plates or surfaces subjected to the pressure obtained from the flowing steam at stated intervals, or by a balancing up of the axial component in the turbines proper.

Clearance and Balancing

In actual operation and in the construction of the machine the chief difficulties which have arisen are due to its high speed and small clearance space. At these tremendous speeds the absolute balancing of the unit is extremely necessary, as small variations acquire a great significance, due to the great centrifugal force. Not only must this balancing be perfect in each and every radial plane but the balancing through each axial plane must be equally perfect. It is not sufficient for a turbine rotor to be balanced perfectly about the axis. Weighting on one side of the wheel at its middle, when viewed through axial section, cannot be compensated by a corresponding weight on the other side unless in the same radial plane. Variations from the condition result in the production of moments exerting an unbalanced pressure on the bearings and a bending couple as well on the length of the shaft.

The steam may corrode the vanes or leave a deposit on them, and a slight shock is sufficient to tear one loose, and the resulting stripping of the entire set is not an uncommon feature. In their re-installation great care should be taken in balancing up from a mass point of view and this, with the difficulty of accurate truing and rigid fastening without distortional strain, is the chief difficulty in the actual operation and maintenance of these units.

The advantage of a high vacuum can be readily understood. The method of the molecules themselves is the factor involved and these molecules move at such a speed, even under ordinary atmospheric conditions, that, combined with their size and colliding properties, they materially modify the problem and make the presence of an incomplete vacuum somewhat analogous to that existing when a stream of water is allowed to flow with considerable rapidity into a comparatively quiescent mass of soft mud and molasses. This will give some idea, more or less incomplete it is true, of typical existing conditions, and explains why a very small increase in the vacuum maintained will have a marked influence on the efficiency of the process in this latter field.

FOR TESTING OF FOREST PRODUCTS the government, through the Department of Agriculture, will establish a new laboratory which, after careful investigation by the Department, has been located at the University of Wisconsin at Madison. The forest service laboratories now located at Yale and Purdue universities and the government's wood pulp and wood chemistry laboratory at Washington will all be transferred to Madison as soon as possible and a force of 15 test engineers and experts will have charge of the work. The university is to furnish the building, light, heat and power, and advanced students will be granted the use of the laboratory for special work. The government will furnish an equipment of a value not less than $15,000.

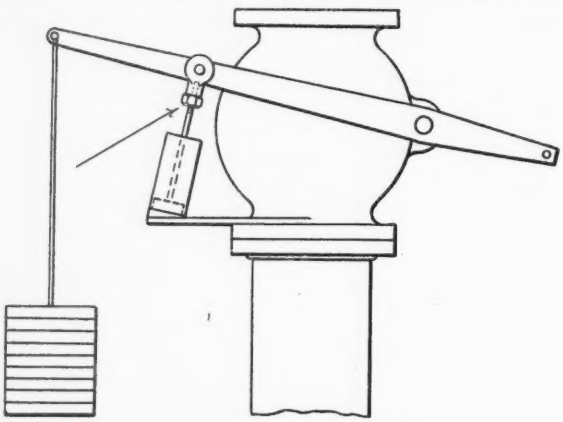
LETTERS FROM ENGINEERS

Send us descriptions of ways of doing new things, and new ways of doing old things. Rough pencil sketches and letters are all right; we will fix them up for the printer. All accepted contributions will be paid for when published.

A Balky Back Pressure Valve

I once had a back pressure valve that was a constant source of annoyance by its continually leaking, making it impossible to carry more than 3 lbs. back pressure which was not enough at certain times. It was situated some 10 ft. above the heater in a very dark place. We notified the maker of the valve who came to see it and advised putting on 125 lb. of weights instead of 60 lb., but with no better result than before. So he agreed to grind in the valve and make it good, for it was only 2 yr. old.

At the time it occurred to me that the gag pot plunger might be resting on the bottom of the pot, which upon investigation was found to be the case. From the cut it will be seen how the check nut worked



THE LOOSE DASH-POT PLUNGER ON THE BACK-PRESSURE VALVE

down allowing the plunger rod to back out and become long enough to hold the weights by resting on the bottom not allowing the valve to touch the seat. Upon replacing the plunger, the valve was absolutely tight.

S. B.

Chlorine and Boiler Explosions

The article by J. M., under the above title in the March issue, was quite a surprise to me, as I thought that the idea of mysterious gases causing boiler explosions was proved an impossibility years ago. But I see he has a new idea in regard to the manner of starting such an explosion. I am not a chemist nor have I made a very extensive study of chemistry, but from what little knowledge I do possess I cannot see how conditions can exist to cause an explosion from chlorine and hydrogen, or how enough of them could be liberated from the impurities in water to do any harm in that way, if proper care was taken of the boiler.

But even so; would they not pass off with the steam to the engine as fast, or, nearly so, as they are formed, rather than accumulate in the boiler? I think so. I am well aware that chlorine has a higher specific gravity, or what is the same thing, weight, than steam, but the current of steam to the outlet nozzle of the boiler would carry it along. Hydrogen, the combining gas, has less specific gravity than steam and would in my opinion, pass off very quickly after being liberated and not stop behind for conditions to be just right for its combination with the chlorine.

Chemistry teaches us that in all combustions of chemical elements conditions must be just right or no combination will take place and the elements will stay separate and distinct from each other. That is the reason why we do not get better combustion in our furnaces, and I can see no reason why conditions should be any different inside than outside of the boiler.

It is my opinion that there was never a boiler explosion yet, that was not caused, either directly or indirectly by lack of care either in its construction or management and such cause could be easily ascertained if all the facts in the case were known. The reports of defects found by state and insurance companies' inspectors prove this.

In this connection I would like to quote from a recent issue of the Locomotive:

"In the 41 yr. covered by the period from Oct. 1, 1867, to Jan. 1, 1909, there were in the United States, Canada and Mexico 10,052 explosions causing the death of 10,884 persons and injuring 15,634 others, a total of 26,318, a truly alarming record. This does not include the largest loss of life in an explosion, that of the river steamer Sultana on the Mississippi river, in 1865, in which the number killed was no less than 1,238, mostly soldiers returning home from the south.

"In the year 1908 there were 470 explosions resulting in the death of 281 persons and 531 injured. These figures do not probably cover all the explosions that occurred, especially in the earlier years, as at that time news of this kind was deemed important only to the immediate neighborhood.

"From the inspectors reports for the year 1908 there were found 151,339 defects, 15,878 of which were considered dangerous. 572 boilers were condemned as unsafe for further use. One interesting item is 322 boilers without steam gages. Another, safety valves overloaded 1,216—379 dangerous.

I do not think there is any need of looking further for the cause of boiler explosions, as these figures point very plainly to the causes. Don't let us try to shift the blame of our own neglect or carelessness onto the shoulders of some mysterious cause, but rather let us be more careful and watchful in the future.

S. E. W.

Engine Repairs

Generally when a part of an engine breaks, if it should happen to be such a part as is necessary for the maker of the engine to replace, it takes considerable

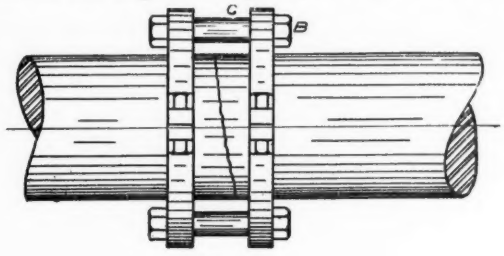


FIG. 1

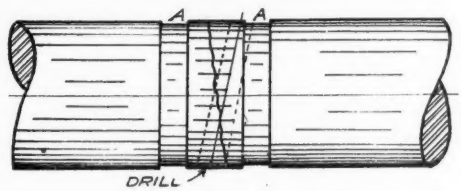


FIG. 2

FIG. 1. THE BROKEN SHAFT AS REPAIRED
FIG. 2. SHAFT WITH HOLE AND GROOVES

time and, if the engine is needed, which is generally the case, it makes it very inconvenient.

Figure 1 shows how a fractured shaft was repaired, and gave fairly good service until a new one was obtained, which was over a week. The shaft was drilled as shown in Fig. 2 to take a taper pin and then rings were filed around it as indicated by letters AA to take clamp rings which were made as shown in Fig. 3 with holes drilled to take bolts and distance pieces as indicated by letters B and C in Fig. 1.

Of course a shaft repaired in this way will not be as strong as the original one, but on account of the safety factor which most makers of engines use at the present time, a person can generally make a repair and then run his engine, giving due consideration for such repair, and in most cases get good results.

Figure 4 shows a way to make a repair to a broken valve rod if conditions will permit. The broken parts are put together and then marked as indicated by letter A, making one side larger than the other so as to form a taper. It is then taken apart and cut where marked, also cutting a key to correspond to the cut made in the rod after which the rod is put together and the key is driven into it and riveted over.

This means of repairing a valve rod only gives it about one-half of its original strength, but with care can generally be used until a new one can be had.

John M. Sewell.

A Smoke Burning Kink

Since taking charge of my present plant, to which I came in 1894, I have been able to reduce coal consumption by fixing the piping so that it cut results from 50 tons of hard coal a year to 37 tons of Cumberland. This fall I had a 2-in. pipe with a ¼-in. slot looking up, put in back of the bridge wall one course below the top of the wall, with one end cemented into the side wall and the other end open through the wall into the boiler room. This is doing great work in burning smoke or gas or both. The ¼-in. slot does not extend the entire length of the bridge wall, as a little is left in the center for support. This device enables me to get the same result running less draft.

John A. Carr.

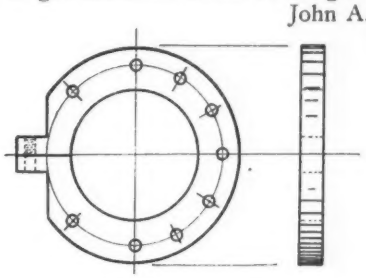


FIG. 3

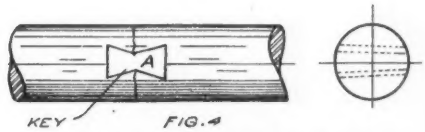


FIG. 4

FIG. 3. CLAMP RING USED ON SHAFT
FIG. 4. REPAIR FOR A VALVE ROD

Oil Separators

In the March issue I noticed an article on the subject of Oil Separators in which Mr. Shenton implies that there is a perfect oil separator. The writer of the present letter is a man grown old in the handling of exhaust steam under many and varied conditions and he has yet to find a layout which he thinks is a safe one to use in returning the products of condensed exhaust steam to the boiler.

At one time I visited a large manufacturing company's plant at its request to find why the sectional boilers were constantly breaking at the joints. They had an abundance of exhaust steam and were using a sort of open heater installation and I felt sure that here was the solution of the whole matter. They thought that they had safeguards against oil getting into the heater and protested against the possibility of oil getting there.

Taking a sample of feed water and using a strong glass, we discovered that it was impregnated with oil in particles too minute to be seen without the glass. careful examination of sections of the boiler taken out also revealed traces of oil, and a change in the manner of heating the feed water, which was suggested and adopted, cured the trouble.

I would like to hear the experience of other engineers along this line and what they have accomplished in the use of exhaust steam for boiler feeding.

H. McG.

Boiler Circulation

No doubt evaporation has its effect to some degree on the circulation in a boiler, but the direction of flow is determined by the action of gravity upon the water.

If an ordinary wash boiler be so placed on the kitchen range that all of the boiler is over the fire as shown in Fig. 1, the circulation will be as indicated, because the water in the center will be hotter and lighter than at the sides,—a question of gravity pure and simple.

If the boiler be turned across the fire, so that the middle of it is over the fire and the left hand end projects free from the stove, the water will circulate from the upper center toward both ends, as indicated in Fig. 2.

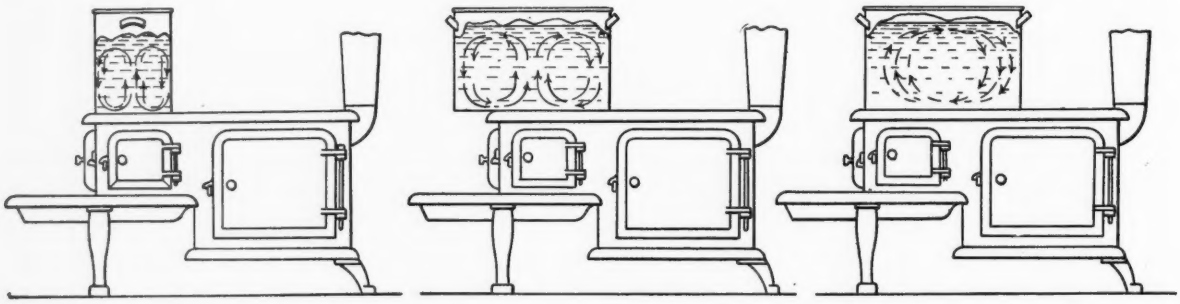


FIG. 1. BOILER DIRECTLY OVER THE FIRE

FIG. 3. FIRE UNDER THE END OF THE BOILER

FIG. 2. HEAT APPLIED AT THE MIDDLE OF THE BOILER

If now the boiler be slid along to the right as in Fig. 3 so that 1 end only is over the fire, the water over the fire will rise and all of it flow toward the right hand, because the left hand end of the boiler stops its progress in that direction,—a purely mechanical proposition in which nothing but gravity figures.

If this reasoning be applied to the fire-tube steam boiler, the water in the boiler directly above the hottest part of the furnace, usually near the back end of the grate, will rise and flow on the surface toward the rear, because the front head stops any part of it from flowing in that direction.

If these 2 propositions are true, then we are safe in assuming that when the water reaches the rear end of the boiler it must sink and follow the bottom of the shell back toward the fire. The feed pipe should be arranged not only to help the natural current of the water but to liberate the comparatively cold feed water in the best possible place.

Some engineers say that when the feed water is introduced at the rear end of the boiler, sediment will be found piled up over the fire. This may be true, but the presence of a pile of sediment over the fire is not so much an indication that the boiler is being fed at the rear as it is evidence that something should be done to dissolve the sediment.

The word sediment, as I understand it, means something that will not float, in this case it means particles of scale that have been loosened up and dropped to the bottom of the boiler when the current of the water washed them along toward the fire to a point where the water turns upward, thus leaving the sediment behind because it will not float.

If I had a tubular boiler in operation, being fed at the rear, through the blowoff pipe, I would leave it so, but in case of a new installation, the feed pipe would be put through the front head, near one side and just above the top row of tubes, the pipe would be carried back to within about 2 ft. of the rear head, elbowed over to the center and down between the tubes about half way to the bottom of the boiler, where the pipe would end.

A longer pipe inside would be apt to scale up; that is, the water should be liberated before it could get hot enough to part with its scale-forming matter. No good way of getting the feed to the particular point and direction of flow mentioned, with a shorter pipe, has been suggested to me. Of course, putting cold water (212 deg.) into a hot boiler in any manner is a piece of brutality, but we have not, as yet, commonly adopted means of avoiding it.

E. G. Tilden.

Switchboard Responsibility

I note in the April issue of the "Practical Engineer" a letter in reply to one in the February issue in regard to the responsibility of the engineer and the switchboard operator.

I differ with Mr. Reynolds, and I will venture to say that the majority of the readers of Practical Engineer will agree with me that the engineer's responsibility does not stop at the point where the energy is delivered to the generator, but in 95 per cent of the central stations over the country, the engineer looks after the operation of the generators. Therefore, he is in charge of the generators. Usually a station electrician is employed, whose duties are to look after all cables from the generator to where they leave the station, make the repairs on the generators and switchboard as they need them, as well as cleaning the brushes, etc. Now, this station electrician is usually under the chief engineer's supervision and where he isn't he usually consults the desires of the chief en-

gineer when he wishes any changes in the station electrical equipment.

The engineer must always be on the alert for emergencies as well as the switchboard operator and in 9 cases out of 10 he has considerably more to do to meet these emergencies than the operator.

The switchboard operator's duties lie in keeping the electrical records, maintaining the proper pressure on the bus bars, dividing the load among the various units in operation, etc.

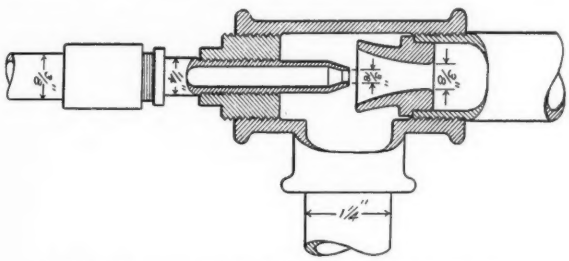
There are plants of 20,000 kw. capacity and greater where the switchboard operators are men who were simply picked up here and there without any electrical knowledge whatever, and just learned the mechanical manipulation of the board.

The writer speaks from the observation he has made during about 20 yr. experience in a number of central stations scattered over 5 states.

Lindon A. Cole.

A Siphon Design

If Mr. Mason would put a funnel as shown in the cut into his siphon, it would work better. I have made



ARRANGEMENT OF FUNNEL IN SIPHON EJECTOR

a number like it and all work O. K., and take less steam.

W. L. J.

Take Out the Packing

Many suggestions have been made relative to the doping or oiling of the engine parts when an engine is laid aside, yet we find one big mistake made in doing this work. It is not an uncommon thing to start an engine that has been laid aside for some time and to find the piston rod badly corroded when the parties who prepared this engine for its rest, never removed the packing from the glands, so that upon starting we find the rods corroded as shown in the drawing.

CORROSION OF ROD BY PACKING

When the rods are allowed to become corroded in this manner it requires a long time to get them worn down smooth again. The rod will cut the packing and blow until worn down smooth and it is astonishing how soon a rod will become pitted under such circumstances.

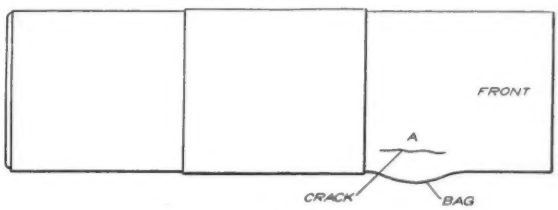
The first thing that should be done in laying an engine aside would be to remove all the packing from the stuffing boxes so as to avoid this damage to the rods.

We find many instances when the cylinder has been opened and coated, yet the packing has been left in the stuffing box to rust or corrode the piston rod and make it hard to get a packing to stand when the engine is next started.

C. R. McGahey.

Burned Boiler

The sketch shows a boiler in a well known shop that employed an unskilled fireman with the result of a burned boiler. All along the fire line and in the



A BAGGED, CRACKED AND BURNED BOILER

flues also it was burned so that they were red. The front section was bagged its entire length. The bag at the joint of first and second joint was down about 8 in. and the plate has a crack about 18 in. long. The bag extended upon the sides almost to the fire line.

The boiler was working with another boiler and carried 100 lb. pressure. Do we need a license law? I think we do, but so far our efforts in that direction have failed in this state, Indiana.

W. W.

Banking Fires

In regard to a method of banking fires described in a recent issue, I think my way is the better.

I clean one side of my fire about 30 min. before closing down and then at closing down time I pull all the fire on the side I have cleaned to the front, and then throw my coal on the bare grates at the bridge wall. I use about 8 to 10 scoops depending on the coal and then push the fire I pulled forward, back over the fresh coal, leaving the grates clean at the front to let any air through that may get in below.

I close drafts and fire doors and open flue cap doors and my steam will not go down at all, and the water will not lower 1 gage if the valves are tight, as they should be. My fire is clean in the morning and by cleaning the other side and spreading the fire, I am ready to start up and always have 80 to 90 lb. steam pressure to start with. I do the same Saturday night, and have 50 to 60 lb. Monday morning, only I use a little more coal.

B. W. Howell.

Indicator Cards from Bates Corliss Engine

I enclose a few cards from my Bates Corliss engine, 16 by 36 in., running at 90 r. p. m. Being used to operate a coal dock the load on the engine is irregular sometimes changing instantly from full load to no load, the effects which are clearly shown by the accompanying cards which were taken with a 40-lb. spring.

E. E. Barclay.

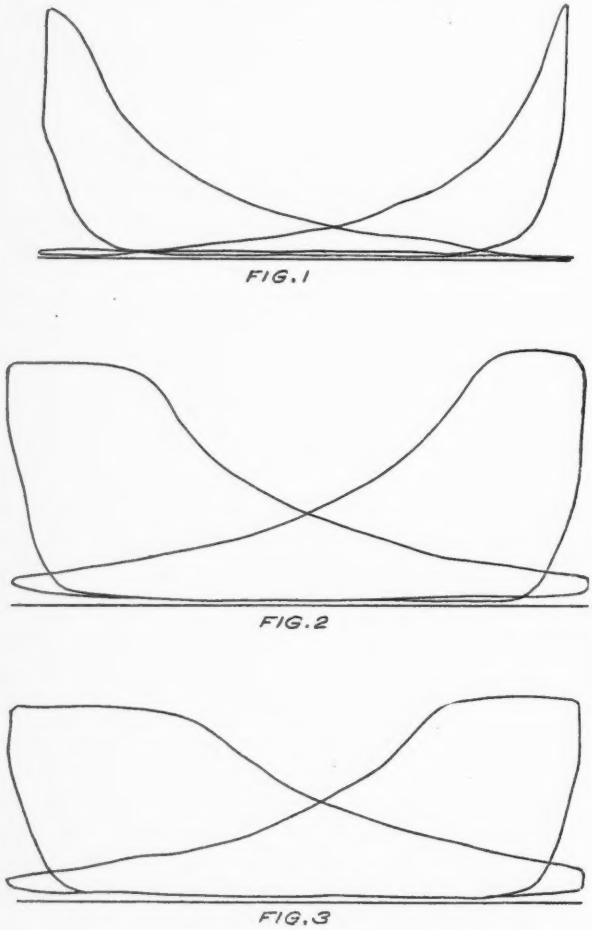


FIG. 1. NO LOAD CARD, BOILER PRESSURE 80 LB.
FIG. 2. ENGINE LOADED, BOILER PRESSURE 75 LB.
FIG. 3. ENGINE LOADED, BOILER PRESSURE 65 LB.

Oiling System

When the 2 vertical cross compound condensing engines in the station where I work were first started up, it took the engineer and oiler all their time to keep the oil cups full; they were either empty or flowing over.

We used to try to regulate the flow by the needle valves over the cups; when we would set them about right they would run for a couple of minutes and stop; if the valve was opened a little more the cup would flow over.

As there was no cleaning done and no time to do it, something had to be done. So I opened the needle valves wide and regulated the oil by the globe valves at A, Figs. 1 and 2. It worked like a charm, but I could not convince the oilers of its merits. They could not see any advantage as they would not take the time to regulate the valve.

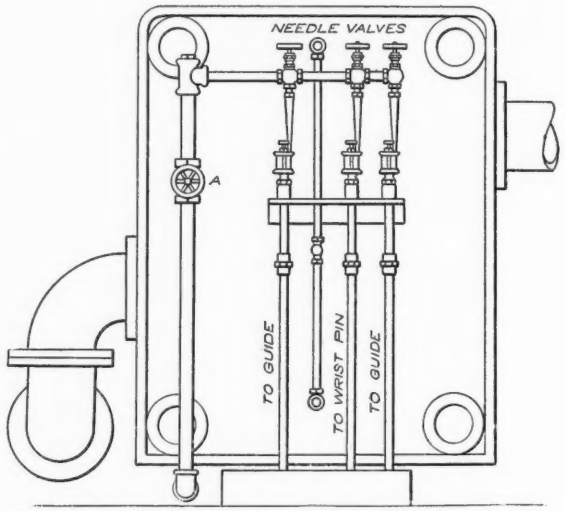


FIG. 1. PIPING AND CUPS FOR THE GUIDES AND WRIST-PIN

Not only the oilers but the chief engineer could not see it, as he thought, if the oilers had it too easy they would neglect their work and let the bearings get hot. But the oilers had to work so hard for the money they were getting, they got through, and new oilers were employed. I had no trouble in breaking them to regulate the flow by the valve at A, now it runs for hours at a time without touching, and the bearings run cool, the oilers have a good job and lots of time for cleaning.

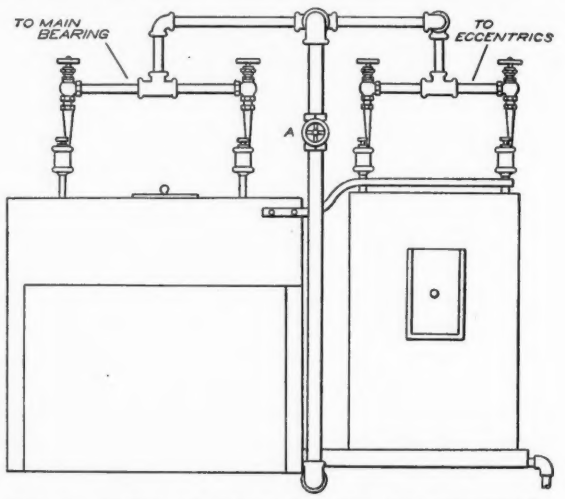


FIG. 2. OILING FOR MAIN BEARING AND ECCENTRICS

Figure 1 is a sketch of one of the high-pressure sides and shows how the piping and cups are arranged for the guides and wrist pin. Fig. 2 shows how they are piped to the main bearing and eccentrics.

Oil runs to the engines by gravity from a tank set up in the trestles under the engine-room ceiling. In

order to get the oil up to this tank a small duplex pump, 2 by 1.25 by 2.75 in. is used, as at 1, Fig. 3. If the pump should fail from any cause, the chief had a galvanized tank made that holds about 25 gal. and piped it up as per sketch.

Should the pump break down valves 2 and 3 are

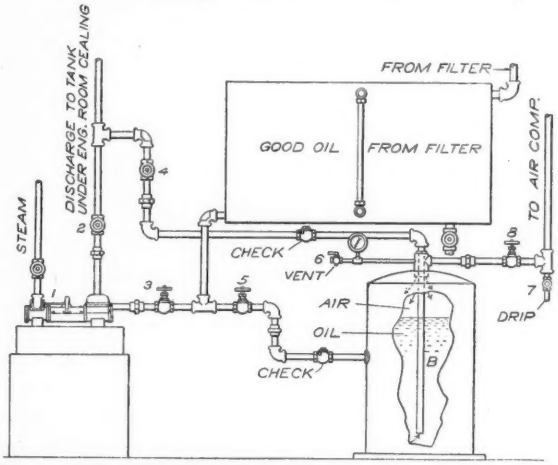


FIG. 3. ARRANGEMENT OF OIL FILTERS, STORAGE AND PUMP

closed and valves 4 and 5 opened, also vent valve 6, the tank fills with oil. The air pump is started and any water in the pipe is drawn off by the drip at 7. Valve 6 is closed and 8 opened admitting pressure to the tank which forces oil out through pipe B to the tank next the ceiling. It works nicely. Although not needed very often, we have something to rely upon and saves lots of worry. Thomas Sheehan.

Machining an Engine Bed

The method of laying out engine beds varies as to the type of engine, but the most essential features of the work are generally the same. There are usually 3 or sometimes 4 operations, owing to the fact that there are more surfaces on some beds than on others.

The bed shown in Fig. 1 has the bearings of the crank

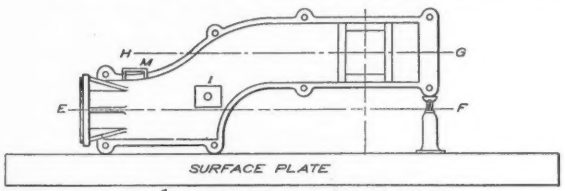


FIG. 1. ENGINE BED ON PLANER

shaft cast solid to it; the cylinder will be fitted female, the bed male, to bolt together. The casting is first put on the lay-out plate, as shown in Fig. 2. Wooden pieces are pitted in the ends A and jaws B to be planed for the journal boxes on both sides of the frame, the center is formed to allow stock to have guides and finish the male part of the frame. It may be found by running the center line C that the journal jaws B will not true up and if so the centers will have to be shifted some to help out, then the line CD is drawn on pointed sticks and on the body of the casting to line on the planers. To plane the bottom a line must be drawn on the casting the right depth from the center line, which is to finish to, then the bed is placed as in Fig. 1 and the distance from EF to GH, found as shown. Next lay off both ends of journal bearing and mark to plane to the height of the governor pad; it must be laid out from the center line, or if the

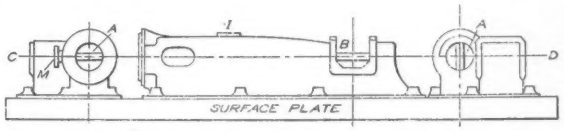


FIG. 2. ENGINE BED ON LAY-OUT PLATE

bottom will plane right the height can be found from the planer bed. After machining the casting is laid out for the bolt circle to which the cylinder is fastened.

Fig. 3 shows adjustable parallel blocks, with which a platform is built up to lay out work upon, such as shear heads and gun work; they can be made in sets of 4 or 6, put on a vertical mill table, and all machined at once to the right height, and can be adjusted easily to the height wanted to suit the work.

Figure 4 shows a handy jack, for laying out the table, made in sections of 3 in., to be built up to suit the height

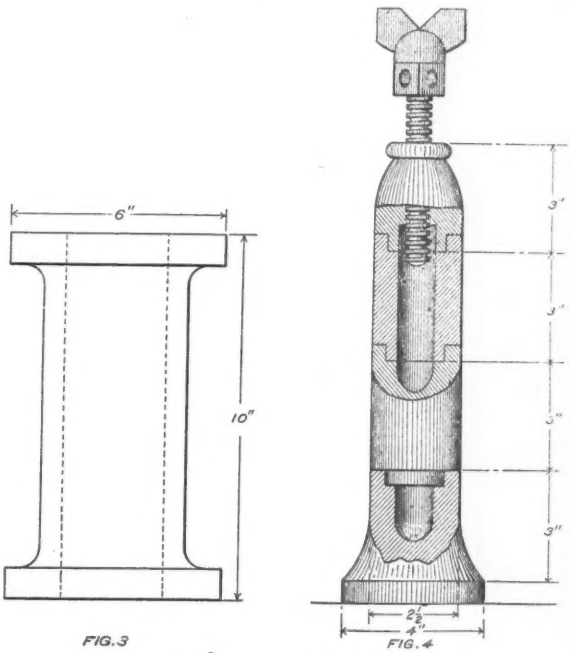


FIG. 3. PARALLEL BLOCK
FIG. 4. ADJUSTABLE JACK

of the job; the first 3 sections are made from 2.5-in. cold rolled stock; the base can be of cast iron.

S. J. Kelly.

GET IN TRAINING all ye engineers who want a government job. A slim man is needed on a refrigerating car because there is only "limited space available." Henceforth dieting will be part of an engineer's training so as to be ready for the "slim" jobs. See News Notes for particulars.

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GAS ENGINE RATING

Among the signs of the times with regard to the increase of the use of gas for power generating, a noteworthy step in such development is the formation of an association of engineers who are operating gas engines or are erecting such engines. This association, The Association of Internal Combustion Engineers, has taken for its objects the making of investigations in the gas engine field as well as the discussion of current practice. One of the investigations undertaken is as to the reliability and efficiency of apparatus and methods of operation; another is investigation of current design and making recommendations as to proportions, material and the construction of engines and accessories; a third is investigation as to the value of different fuels under varying conditions.

The first activity of this sort is the effort to establish a uniform commercial rating for internal combustion engines. In pursuance of this policy, letters have been sent out to manufacturers of such engines asking their opinion on the following points: First, desirability of a uniform rating; second, whether this rating should be based on actual brake horsepower when using a specified fuel at a specified speed approximately at sea level; third, whether this rating should be that load at which the engine will give highest fuel economy; fourth, whether, as such determination would be difficult, rating might better be determined by making it a definite percentage less than the maximum brake horsepower, regardless of fuel economy; fifth, if this is desirable, what percentage less than maximum shall be the rated load; sixth, what shall be the leeway allowed in testing engines for capacity. The suggestion is made that the rating should be 15 per cent less than maximum output and that an engine which is fairly rated should be capable of not less than 10 per cent nor more than 25 per cent overload.

In sending out its letter, the committee of the association has had in mind the fact that it is now possible to purchase in the market 2 engines rated at the same horsepower, one of which will not carry the full rated power while the other will carry nearly double its rated power. The committee believes, therefore, that some definite rule or method of rating should be established to avoid such inconsistencies and so that a buyer of a gas engine will have a fairly definite idea of how much power he is really able to get from the engine that he buys.

This movement is, of course, in line with the tendency to standardization of commercial products. While steam engines, electric motors, water wheels and air compressors are reasonably standardized as to size, so that an engineer can tell fairly well what power he ought to get out of a given machine, the gas engine,

and especially the gasoline and oil engine, has been rated as No. 1, No. 2 or No. 10, as the case might be, the rated horsepower sometimes being stated, sometimes not, and the dimensions being carefully withheld in all catalog literature. One or 2 notable exceptions come to mind in this connection, but the practice of rating an engine by horsepower without telling how big it is has been nearly enough universal so that engineers are justified in wishing for a different state of affairs.

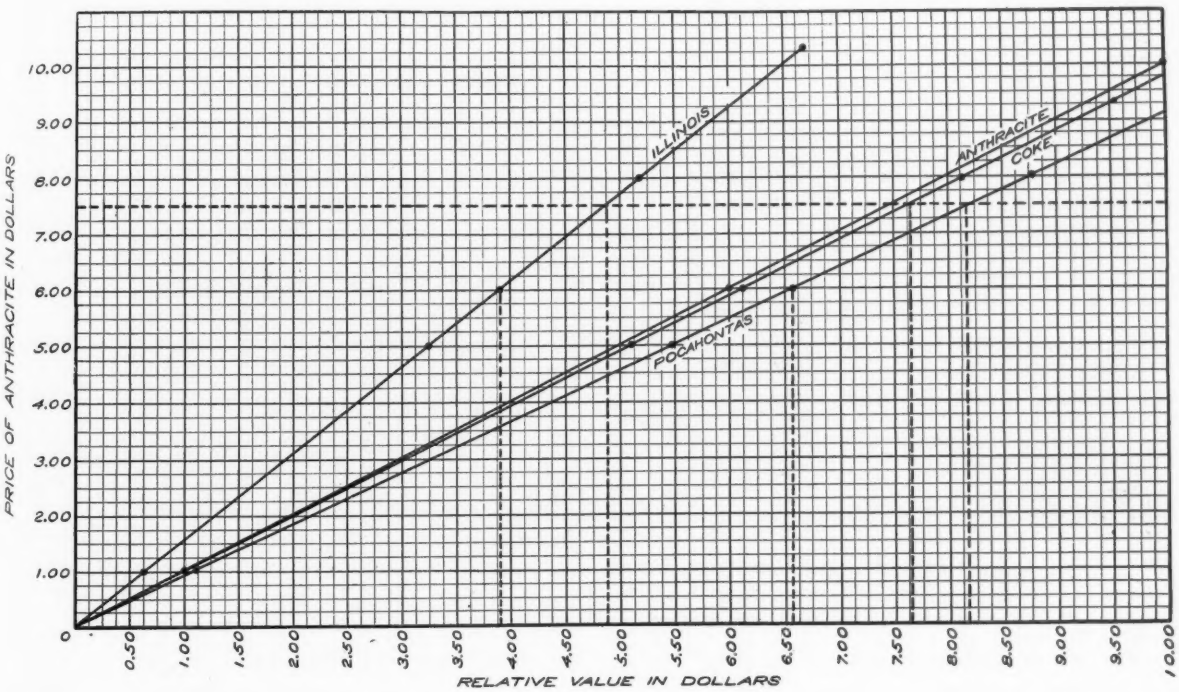
The new organization has taken up a question that needs settling and if it continues in this line of work will make for itself a safe place in the organizations of the country. The experience of engineers in other lines has proved the benefit to be derived from association and co-operation and it is a matter of congratulation that the operating engineers in the gas engine field are banding together to pool their common experience and all make progress by so doing.

COAL FOR HOUSE HEATING BOILERS

This is a subject that interests vitally every householder and the results obtained by tests made at St. Louis in the government fuel testing plant and at the University of Illinois in the state engineering experiment station plant mean dollars and cents to every man who handles a house heating boiler for either steam or hot water. The reliability of those engaged in the experiments makes the results unquestionable, and although it is certain that a house-heating boiler does not burn the bituminous coals which have high volatile matter so efficiently as do power boilers, yet the diagram herewith shown, which incorporates the findings from the experiments, shows conclusively that anthracite coal is a luxury in localities where it costs over $5 a ton.

The use of the diagram is this: If, as in the region of Chicago, anthracite coal costs $7.50 a ton in the sizes used for house heating, starting with $7.50 in the vertical index at the left and passing horizontally to the right, it will be seen that Illinois coal is worth $4.90 as shown by the vertical line which intersects the Illinois coal line on the $7.50 horizontal.

Coke is worth $7.60 and Pocahontas coal about $8.15. Not one of these 3 fuels sells in this locality for such prices, so that anthracite is a luxury over Pocahontas by about $3 a ton. Coke alone burns rather too freely in a house heating boiler except in the coldest weather, on account of the large air space through the fire but experiment has shown that by using a mixture of coke and fine bituminous coal, either Illinois or Pocahontas a satisfactory fire may be maintained in all seasons and a substantial reduction made in the coal bill for the house without the production of smoke.



WHEN STARTING A MOTOR the starting box should not be cut out too fast. For motors up to 20 hp., taking 50 per cent over the full load current when starting, 15 seconds should be taken in starting up; for motors above 20 hp. up to 50 hp., 30 seconds should be taken; while for motors from 50 to 100 hp., 45 seconds should be taken. It is better to start slower rather than faster than these figures give.

ELECTRICAL MACHINERY AND APPARATUS

APPLICATIONS OF THE MERCURY ARC RECTIFIER

FROM the early history of electricity as a commercial product the problem of converting alternating current into direct current has been one of the most important before electrical engineers. In the direct-current generator this is accomplished by means of a commutator and this principle is also employed in the rotary converter. Of recent years there have been invented a number of devices which have proved more or less successful for this purpose; the one, however,

FIG. 1. MERCURY ARC RECTIFIER SET

which has become the most prominent, and growing in favor is known as the mercury arc rectifier.

Theory of Mercury Arc Rectifier

The operation of the mercury arc rectifier depends upon the fact that mercury when used as a negative electrode in a vacuum emits a vapor which is a good conductor. In applying this principle for commercial use an exhausted tube is employed with one or more mercury electrodes. The ionized vapor from the negative electrode, or cathode, which is caused by the mercury being in a state of agitation due to the current which passes through it, fills the tube and makes it a conductor of electricity. This condition of agitation is kept up only while the current is flowing toward the negative electrode, therefore a reversal of the direction of the voltage would stop the current after a half cycle were some means not provided to keep a current flowing until the next pulsation of the alternating current.

In the rectifier built by the General Electric Co., 2 graphite electrodes, called anodes, are employed; each anode is connected to one side of the alternating-current circuit and also through a reactance to one side of the load. The cathode or mercury electrode is connected to the other side of this load; thus it will be perceived that as the current reverses in the service line, first 1 anode then the other becomes positive; the cathode continues to remain negative. The discharge of one reactance maintains a current until the voltage at the other anode becomes sufficient to overcome the counter e. m. f. of the load and also reduces the fluctuations in the direct current. By this means of transforming alternating current into direct current, the loss is small.

A small electrode connected to one side of the tube

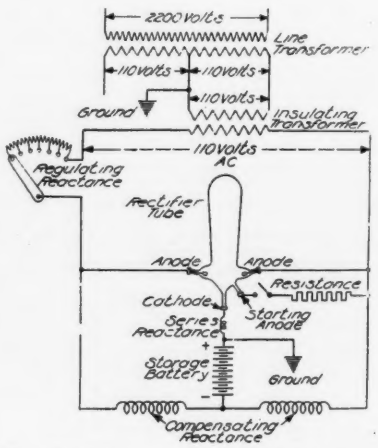


FIG. 2. DIAGRAM FOR CONNECTING RECTIFIER

is provided for starting the arc. This is accomplished by shaking the tube slightly, thus forming a mercury bridge between the small electrode and the cathode and this bridge, when broken, draws an arc and maintains the mercury electrode as the cathode. The starting anode is connected through a resistance to one side of the alternating current line and when once the current has started this connection is broken by means of a switch.

Application of mercury arc rectifiers is not confined to any one particular use or industry, but may be employed in nearly all cases where direct current is required. The principal uses to which this apparatus is adapted at the present time are the charging of storage batteries of all kinds, operating series arc lamps, running small direct-current motors from an alternating current circuit, for railway signal systems, electroplating, etc.

Charging Storage Batteries

The present demand for an apparatus to charge storage batteries from an alternating-current circuit has led to the adaptation of the mercury arc rectifier to this use. The commercial sets as manufactured by the General Electric Co., of which Fig. 1 is an illustration, consists of 4 parts, the panel, regulating compensator, rectifier tube and reactances.

The panel employed for this purpose is self contained and requires only to be connected to the secondary service lines to be put into operation. Completely equipped, the panel requires a floor space of about 16 by 18 in. and stands 5 ft. high, being provided with a direct-current ammeter, a voltmeter, a double pole switch for connecting to the line, a direct current circuit breaker to protect the apparatus from an overload, and other necessary switches for starting and operating the rectifier. The starting resistance is placed upon the back of the panel and connected to the rectifier by a single-pole double-throw spring switch on the front of the board.

Accurate voltage control is obtained by a regulating switch, which consists of 2 sets of contact buttons, one for rough and the other for fine adjustment, connected to various points of the regulating reactance coil, which is placed in the alternating-current circuit in series with the rectifier, as shown in the diagram Fig. 2.

Rectifier tubes vary in size according to the current, and in shape according to the direct-current voltage. At present the sets manufactured for the purpose of charging storage batteries range in current capacity from 10 to 40 amperes and in direct-current voltage from 25 to 250. When a greater capacity is required than can be supplied by one set any number of these may be operated successfully in parallel. The electrodes of the tubes are protected by metal cups, which aid in making the connections to the line and load. The tube is supported in a metal frame, pivoted to the back of the panel in such a way that it may be rocked by a handwheel on the front of the board.

The reactance coil is placed in an iron case upon the floor beneath the panel. This coil is connected directly across the line and maintains current during the reversal of the voltage on the alternating-current circuit. Three leads run through the case, and are connected to the panel as shown in the illustrations, Figs. 1 and 2.

When desired, an automatic starting device consisting of an electromagnetic rocker is used and is desirable where the load or voltage fluctuates excessively, which condition would stop the operation of the converter. if some means are not provided for automatic starting.

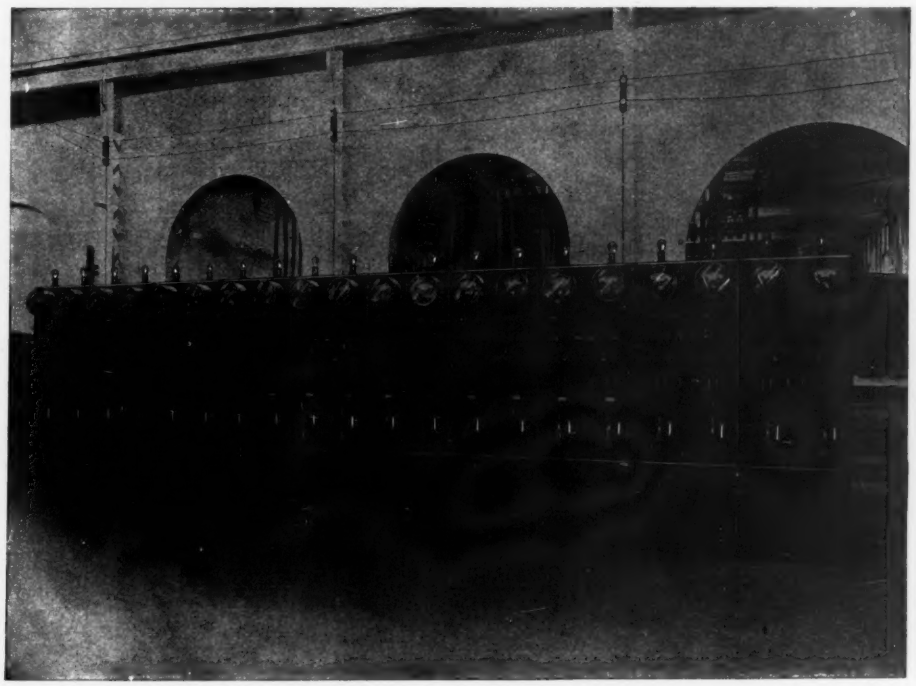


FIG. 3. SERIES ARC RECTIFIER SWITCHBOARD AT FALL RIVER

The efficiency of the rectifier varies with the direct current voltage delivered, as the loss in the arc is constant. Tests have shown the efficiency of a 30-ampere set operating from a 110 or 220-volt, 60 cycle alternating-current circuit, to be over 75 per cent from 0.25 to full load at a direct-current voltage averaging 80, and over 80 per cent for direct-current voltage averaging 112.

Series Luminous Arc Rectifier System

Among the more recent applications of a mercury arc rectifier is that for use upon a constant-current series arc system. An installation of these rectifiers

has recently been made in Fall River, Mass., for the purpose of converting the alternating current into constant direct current for series luminous arc lights. The switchboard of the plant is shown in Fig. 3.

It has long been known that the direct-current lamp gives a more satisfactory light than can be obtained from an alternating-current circuit, but the expense of installing motor generator sets or other special machinery for delivering the constant direct current has heretofore limited the use of the direct-current arc lamp. The mercury arc rectifier, however, is admirably well adapted for this purpose and makes possible a better street lighting at low initial and maintenance cost.

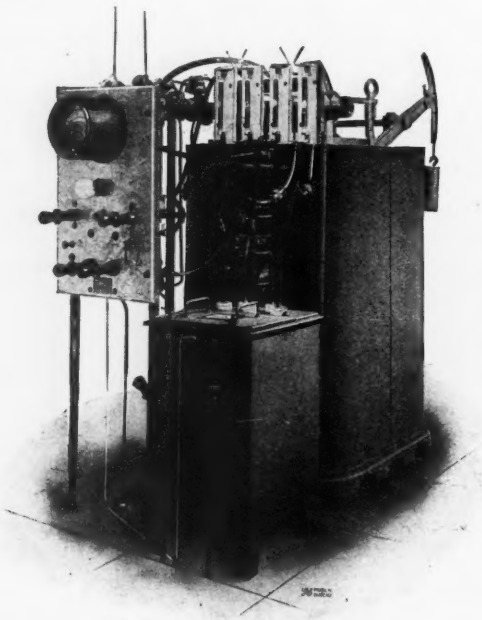


FIG. 4. COMPLETE RECTIFIER SET FOR 50 LIGHTS

A rectifying outfit as manufactured by the General Electric Co. for use on series arc light circuits is shown in Fig. 4 and consists of a constant-current transformer, direct-current reactance, transformer for exciting the tube, tank for the rectifier tube, static discharge, series mercury arc rectifier tube, lighting arrester and switchboard panel. The constant-current transformer used with the rectifier outfit has the same characteristics as those used wth series alternating arc lighting systems, the method of cooling the transformer being by means of a draft of air.

The primary coils of the transformer may be designed for any alternating-current voltage or frequency. The secondaries are connected to the anodes of the rectifier and the voltage at the terminals is governed to suit the system in use. A tap at the middle of the secondary connects the transformer through a direct-current reactance to the direct-current circuit on which the lamps operate; this is clearly shown in Fig. 5.

The sets are made in standard sizes, varying in capacity from 12 to 100 lights and are suitable for use on primary circuits of voltages ranging from 4,400 to 13,000, the range of frequency employed being from 25

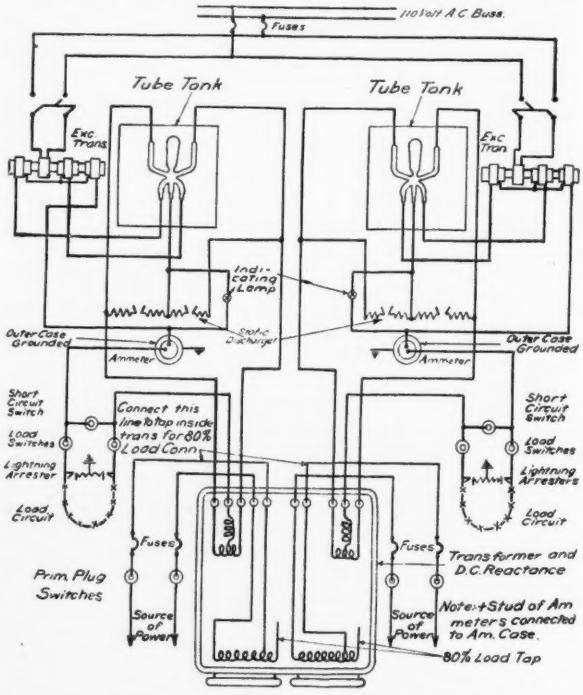


FIG. 5. METHOD OF CONNECTING 2 SETS IN PARALLEL

to 140 cycles, the standard sets, however, being designed for a frequency of 60 cycles, will give best results when employed on circuits of this frequency.

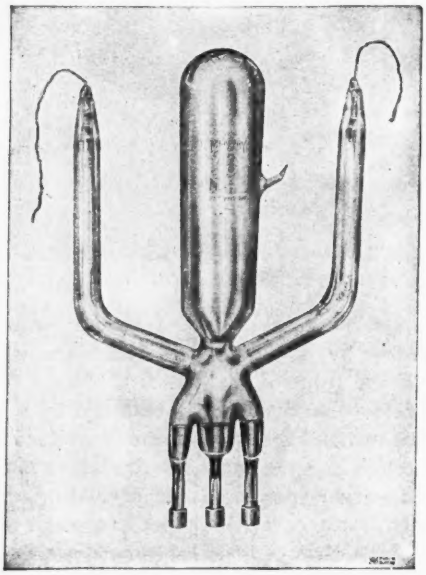


FIG. 6. RECTIFIER TUBE FOR SERIES ARC LIGHTING

The efficiency of the rectifier sets when operated at full load with rated primary voltage and frequency varies from 85 to 90 per cent and under the same conditions the power factor varies from 65 to 70 per cent.

The rectifier tube which is used in the lighting system is similar to that for charging storage batteries with the exception that 2 mercury starting anodes are employed, which are placed on either side of the mercury cathode. This is clearly shown in the illustration, Fig. 6. The tube is operated in an iron tank containing oil kept at the proper temperature by means of water flowing through a cooling coil. When operated at 4 amperes there is a drop equivalent to 25 volts or a loss of 100 watts in the tube, which is constant at all loads.

A special exciting transformer of about 100 watts capacity is used in starting and exciting the rectifier tube. The primary of the transformer is connected to the low-voltage circuit and the secondary to the starting anodes of the tube; a tap at the middle of the secondary is connected to the cathode or negative terminal at the bottom of the tube. After starting the tube the exciting transformer can be disconnected from the low-voltage circuit by a switch on the panel.

For protecting the tubes and other parts of the apparatus from excessive electrical strains, static dischargers are employed, which are connected, as shown in the diagram, Fig. 5. The horn type lighting arrester with series resistance is used on the secondary circuit of series rectifier sets.

The switchboards are designed for operation immediately in front of the constant-current transformer and contain all necessary meters, circuit breakers, starting devices, switches, etc. Any number of switchboard panels or sets may be placed in parallel and the rectifier may thus be arranged to suit the needs of a plant of any capacity.

STORAGE BATTERY COMPENSATOR.

By M. C. Saeger

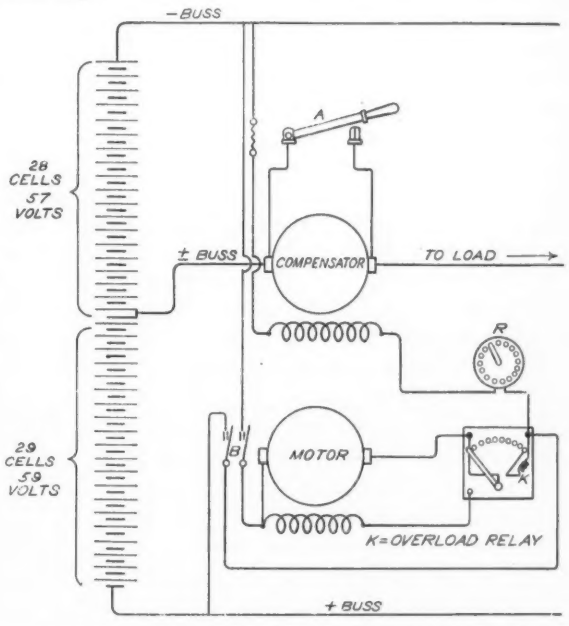
IN A plant operating with direct current at 115 volts and using a storage battery it is often found necessary in order to obtain a total battery voltage somewhat near the line voltage that an uneven number of cells be employed.

When a neutral feeder is taken from a battery consisting of an odd number of cells, there will be 1 cell more on one side than on the other. The absence of one cell will have little effect on the half battery e. m. f. while discharge is being carried on; but when the charging current is put over the line with a balanced load on the half batteries, the side with the least number of cells will have a tendency to drop its potential at least 8 to 10 volts, while the other side will rise in proportion.

The compensator in the accompanying diagram will serve to illustrate how this fault may be overcome. When the load is equally balanced on both sides of the battery while the charging current is flowing, the negative half battery will have a lower voltage than the positive half; this drop in potential can be compensated by raising the output of the compensator. If the positive side of the battery carries the greater load, then the compensator e. m. f. must be lowered through resistance R in order to have both sides of the battery at equal voltage.

The compensator field is separately excited from the battery total voltage, in order that the field may have the benefit of the voltage as it increases in the course of charging.

The capacity of the compensator in this case is 1 kw., 100 amp. at 10 volts full load 1,500 r. p. m., allowing 50 per cent overload for short periods. The motor-starting box is equipped with a magnetic overload trip.



CONNECTIONS FOR STORAGE BATTERY COMPENSATOR

When the compensator is shut down while in the circuit, due to overloading, current for the neutral feeder flows through the armature windings. The armature winding is in 2 parts with 2 commutators and has the capacity to carry the full load of the neutral feeder, and also to generate 10 volts full load without excess heating. Switch A is closed when compensator is shut down and battery on discharge.

FOR SINGLE BELT from the back of the hide, oak tanned, the weight is very closely 16 oz. per sq. ft.; for light double belt 24 oz.; for medium double belt 28 oz.; for standard double belt 33 oz., for 3-ply belt 45 oz.

IN A REPORT on the development of water power for certain mill property, F. W. Dean, of Boston, shows that the value of water power is less now than it was in 1843 when the first development was proposed at the site in question. At that time making power by steam was expensive, as the engines were crude and of large size for the power developed, while the economy of compounding was not understood until about 1870. Although the value of this water power has decreased, it still has some value because of the investment in it, but Mr. Dean shows that, if the investment were not now made, the owners would be better off without the water power plant. The conclusion applies, however, only to the particular case in hand and each case must be investigated on its own merits.

WHAT PACKING SHALL I USE

By W. E. Sanders

Valve Stems

For valve stems and admission valves of Corliss engines care must be taken to have a packing which can stand the temperature well. While on a slide valve the valve rod is alternately in the air and in the steam and its temperature is therefore lower than the steam, yet the temperature of the stuffing box around a valve stem is very much higher than that of the stuffing box or engine, since it is always in contact with live steam, and the use of asbestos, or inorganic packing, must be started at a lower temperature than in the case of main rod packing.

One device, which is used and is pretty successful, is to place in the bottom of the box an asbestos ring which is close-fitting, and on top of that to use fibrous packings. The asbestos acts as a sort of buffer to prevent the extreme heat from reaching the rest of the packing, and the result is a longer life to the packing.

Hydraulic Packing

On water packing, which is hydraulic packing, the conditions usually met are high pressures. For ordinary service-pump work the pressures are not so high, but the temperature may run quite high. The conditions in pump service are sometimes quite severe. An end-packed plunger pump supports the weight of the plunger on the packing and this is hard for the packing. The hot, almost boiling, water carries the heat to the packing in quantities as it is not carried by steam. Steam is more intense, but it does not seem to get to the packing and have the same effect as the water heat. Outside of this, for hydraulic work packing has nothing to fear from pressure. Almost any form of packing can be used, but the uses of hydraulic work are much more varied than those of steam, and for special cases some packings would be of no use at all.

Metallic Packing

For very many purposes it is better to use metallic packing than to use fibrous packing. This is particularly true where a loss of time used in replacing packing would be very costly. For instance, the blowing engines of blast furnaces. When wind is not supplied regularly to a blast furnace the loss in output of iron is almost directly proportional to the loss of wind. It is evident that a 20-min. shutdown because of packing would pay for hundreds of sets of packing. In central power plants for street railroads or for illumination it is an expensive proposition to have to shut down, for if there are no spares handy, it will mean a suspension of service. Under such conditions it is by all means best to use metallic packing.

The same principles of packing may be applied to metallic packing as to fibrous packing, and a packing should be chosen which is as near as possible independent of the engineer, after having been placed in position. The better of these packings are of the cage type. They give a good report of themselves on the item of steam economy and while they seem to be expensive at the outset, yet when the expense is divided by the number of years of service they are shown to be very economical, and when the time of the engineer in placing packing is taken into consideration the odds are in their favor. It must be borne in mind, however, that metallic packings are best only on rods of 2-in. or over. For smaller sized rods they do not give so satisfactory results.

EXAMINATION QUESTIONS

By James Browning

HOW do you set the common slide valve?

A.—Give the engine the desired amount of lead when the engine is on dead center; when the eccentric is in midposition the valve should be central. The

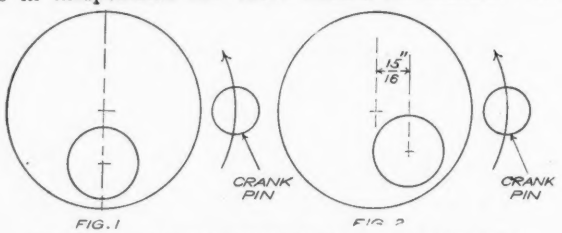


FIG. 1. ECCENTRIC POSITION FOR NO LAP OR LEAD
FIG. 2. ECCENTRIC POSITION SHOWING ADVANCE FOR LAP AND LEAD

valve of an engine is usually set as accurately as possible, and then after indicator cards have been taken the final adjustments can be made and slight irregularities corrected.

The lap on the common slide valve can not be changed without considerable labor, and the radius of the eccentric, which determines the travel of the valve,

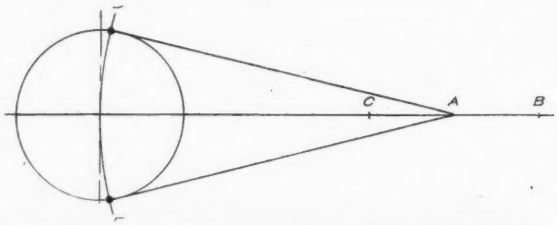


FIG. 3. DIAGRAM OF CONNECTING ROD ANGULARITY

is usually fixed, therefore the adjustable parts are commonly the length of the valve stem, and the angular advance of the eccentric. By lengthening or shortening the valve stem the valve is made to travel an equal distance on each side of the middle position.

Changing the angular advance, in other words, moving the eccentric on the shaft, makes the action of the valve come earlier or later, as the angular advance is increased or decreased. It must be remembered that when the eccentric is plumb, that is, directly above or below the shaft, the valve must be central upon its ports, therefore should any valve rod or eccentric rod

slip or get loose or a new one is to be inserted, all there is to do is to plumb the eccentric and center the valve; then the rods can be screwed into place, for when the eccentric is in midposition, the valve is there also, for if it were otherwise, the eccentric would open one port wider than the other.

2. What is meant by the angular advance of an eccentric?

A.—It means the angle by which the center of the eccentric is advanced more than 90 deg. from the crank pin. With a direct connected engine, the eccentric leads the crank pin a quarter of a turn; that is, if the valve had no lead or lap, the eccentric would be at

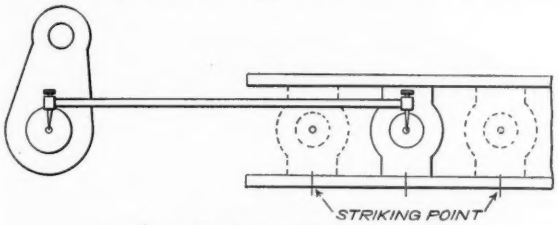


FIG. 4. METHOD OF USING THE TRAM

right angles to the crank as shown in Fig. 1. But we will assume that the valve has 7/8 in. outside lap and 1-16 in. lead, therefore we must still further advance the eccentric to give that amount in order to get the required amount of valve opening at the beginning of the stroke as shown in Fig. 2.

3. What is meant by a long or short connected engine?

A.—It means a long or short connecting rod. High-speed engines have short rods. Engines running over 100 r. p. m. are considered high speed.

4. What is meant by the angularity of the connecting rod?

A.—The angle of the connecting rod changes the

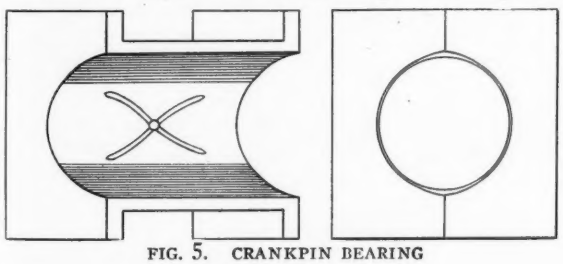


FIG. 5. CRANKPIN BEARING

piston position according to the position of the crank pin. The point A in Fig. 3 represents the center of the crosshead pin. If the crank pin was on the forward dead center it is evident that the center of the crosshead pin would be at point C, while if the crankpin was at the back dead center the crosshead pin would be at point B, which indicates the extreme back travel.

It now becomes necessary to locate the position of the crankpin at half stroke.

It is evident from the above explanation that the length of the connecting rod must be equal to the distance from the center of the shaft, to the middle point between B and C; this point indicates the center of the crosshead pin travel and therefore the half stroke of the piston is indicated by the letter A.

To find the position of the crankpin at half stroke we must proceed as follows: from the point A with a length equal to the length of the connecting rod, describe the arc D E. The 2 points where the arc intersects the crankpin circle must therefore indicate the position of crankpin at half stroke. We find that these 2 points are farther back, nearer the crosshead than

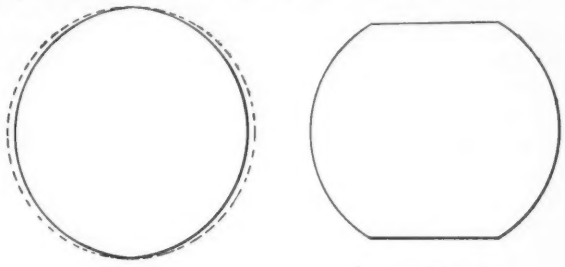


FIG. 6 FIG. 7

FIG. 6. WEAR IN WRISTPIN BEARING

FIG. 7. METHOD OF PREVENTING WEAR IN WRISTPIN

the top or bottom quarter, which shows that the crankpin must travel farther while the crosshead pin travels from A to C than it would travel while the crosshead pin moved from A to B.

It is surprising how few engineers know how to get the correct length of a connecting rod should the engine rod be missing, bent, or broken. They start in by telling that they would put the engine on dead center, but they forget that, if the connecting rod was missing, it would be an impossibility to place the engine there without it. Then they talk about finding the clearance, which is quite a mathematical problem when the rod is gone.

The correct way is to push the piston to one end of the cylinder and mark the striking point upon guide and crosshead; then push piston and crosshead to the other extreme end and mark the guides again; you have now found the striking point. Find the middle between these striking points and place the mark on the crosshead at this position, then tram from the center of the crosshead pin to the center of the main shaft as shown in Fig. 4. By this method you pay no attention to clearance or to the position of the crank which, if it is a big engine, is quite an item.

5. What is meant by an engine traveling over or under?

A.—An over-running engine is one that has the top of fly wheel running away from the cylinder; an under-running engine would be the reverse.

6. What is meant by the clearance of an engine?

A.—The distance between the piston and cylinder head. When the crank is on dead center and the piston at the end of the stroke, there is always some space between the piston and cylinder head. The volume of this space plus the volume of one steam port is the clearance proper. In other words, the clearance may

be defined as the volume of steam between the valve and piston at the end of a stroke. In order to determine the clearance in cubic inches, it is necessary to place the engine on center and fill the space between the piston and cylinder head, also the steam port, with water. The volume of water poured in is the clearance.

7. What is the cause of crank pins heating?

A.—Too much bearing, pounding, key too tight or want of lubrication. The answer that an examiner is looking for when asking what causes crank pins to heat is too much bearing; a brass in this condition may not get hot enough to throw the babbit, but will always run uncomfortably warm. In filing a brass, place some red lead and oil evenly over the pin, then place the brass squarely on the pin and rock back and forth 2 or 3 times. Upon removing the brass, the high spots in the babbit may be found by the red lead adhering to it, which should be scraped away a little at a time, being careful not to scrape too deep, as in that case it would mean considerable scraping at some other place. Continue this until the brass shows a fair bearing all around.

As all the work is done by the push and pull of the rod the babbit in the center of the brass wears faster than that at the extreme top and bottom; in fact, the top and bottom of a brass have practically nothing to do and should be scraped away as shown in Fig. 5. This takes care of the uneven wear and with an engine that is working at full load there is more or less spring to the brasses and if an even bearing were allowed all around it would soon give trouble.

It must be remembered that an engine does the hardest work before cutoff, there being less strain on the pin as the steam pressure diminishes in the cylinder, thereby causing the pin to wear out of round. In keying an engine in this condition always place the engine on the top forward eighth; or in other words, key up on the biggest part of the pin, thereby insuring a free bearing all around at any position of the crank.

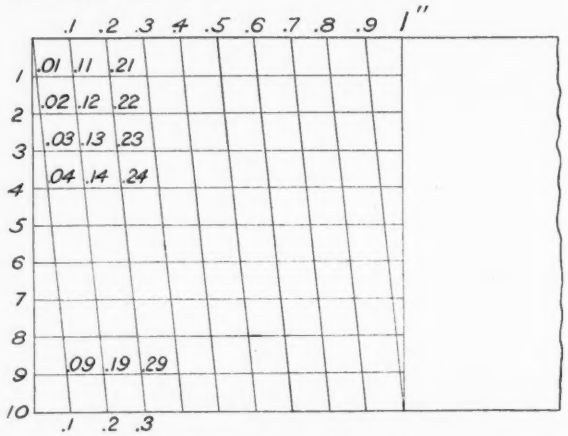
With the wrist pin, crosshead pin, this uneven wear is more plainly shown, there being absolutely no wear on the top and bottom of the pin, as it remains stationary, and in a short time will wear as shown in Fig. 1 and the brass scraped away the same as before. In keying a crosshead pin always place the engine on the top quarter as in that position you get the largest part of the pin should there be any difference.

A HOMEMADE DECIMAL RULE

By A. L. Hodges

MANY a time a decimal rule is needed when there is none handy, so below is given a simple method of making one in a few minutes to read to hundredths, or, in fact, any decimal, for any unit desired. This one is believed also to possess the quality of not hurting the eyes and of not getting one mixed up in counting the number of divisions from some marked unit. It does not need a magnifying glass for efficient use either, as the divisions are easily distinguished on the scale.

The unit is first chosen, say an inch. A square inch is then drawn and each side divided into tenths. Horizontal lines are drawn from the vertical divisions. From the zero top horizontal division draw a diagonal line to the bottom 0.1 division. This line, as is seen in the diagram, cuts each successive horizontal line 0.1 of a division, and consequently 0.01 of a unit (in this case an inch), farther from the zero point. Thus the rule is just moved until the desired length to be measured coincides with the correct division and it is immediately read off.



HOME-MADE DECIMAL RULE

This has several advantages over a machine made horizontal scale. The lines can be made as fine as desirable with a drawing pen; consequently we have no wide marks to estimate "about," and no deep grooves to reflect the light and hurt the eyes.

It will be seen at once that this method not only applies to a decimal system but to any system desired. The least count of such a rule is obtained by multiplying the fractions denoting the division on each side together. Thus in the figure it is 0.1 by 0.1, or 0.01. If it had been divided into eighths, it would have been ⅛ by ⅛, or 1/64.

PIPING KINKS

By R. Cederblom

EVERY engineer is not an expert steamfitter but there are few who do not at some time or other run up against a job of pipefitting. In every engine room an assortment of fittings and pipe ought to be kept on hand because when a job has to be done it is generally done on Sunday or at night when supply-houses are closed and desired fittings not obtainable. They should be kept in separate and lettered apartments so that a man can lay his hand on any size fitting instantly without having to look through the whole stock on hand.

Another thing that saves time on smaller size work

is to have a full set of nipples and holders on hand, that is a piece of pipe with a long thread and a good heavy coupling as shown in Fig. 1. When cutting threads use a good grade of lard oil, even if you have to pay for it yourself. It's a good investment. It is not pleasant after one has gone to the trouble of measuring, cutting and threading a pipe to find the threads all chewed up when backing off the die; besides it saves wear on the dies and a lot of elbow grease.

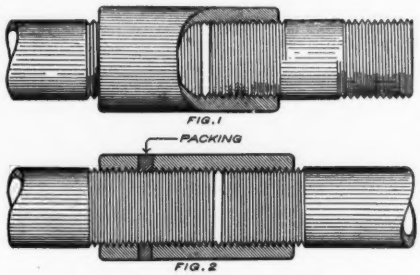


FIG. 1. NIPPLE HOLDER
FIG. 2. UNION MADE FROM COUPLING

A 3-wheel pipe cutter is handy in a tight place but an inexperienced hand is almost sure to make a slanting cut, with this type, which leads to a crooked thread unless the guide bushing is a good fit on the pipe; so the cutter with a roller is better for general use at the bench. If in need of a union a very serviceable one is easily made out of an ordinary coupling and some packing as shown in Fig. 2.

When handling heavy pipes requiring 2 or more men, be sure that the thread is good by trying some spare fitting that's handy, then block the length of pipe so as to be in line or facing the fitting it is going to

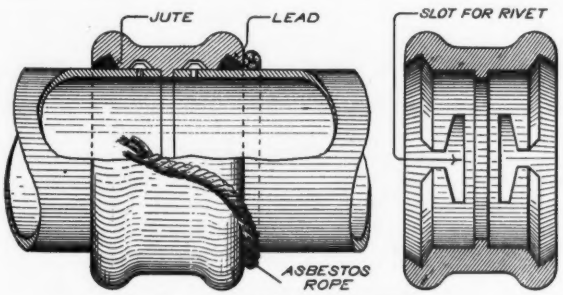


FIG. 3. HYDRAULIC PIPE JOINT

enter squarely. It is only waste of time to depend on your helpers to hold it straight and turn it at the same time.

When using rubber gaskets on flanged joints do not cut the gasket the full size of the flange, just a ring that fits inside the bolt circle; this saves work on cutting holes for the bolts, saves packing material and is more convenient to put in.

When repacking an old joint do not remove all the bolts, leave 2 or 3 with the nuts slacked back to allow of ¼ or ⅜ in. opening between the flanges. Pipe lines that have been in use for any length of time are more or less out of line, due to expansion and contraction, and if all the bolts are removed it is often troublesome to get them back into place. When working on top of boilers or beside hot steam pipes every minute saved counts.

It is seldom that a steam engineer is called upon to do any work on hydraulic pipes and fittings employing lead joints unless in charge of pumping stations. This kind of work is, however, not difficult. One joint extensively used is shown in Fig. 3. A slot is provided for the rivet to enter the fitting to get a good fit, and when the pipe is in line and after which one or the

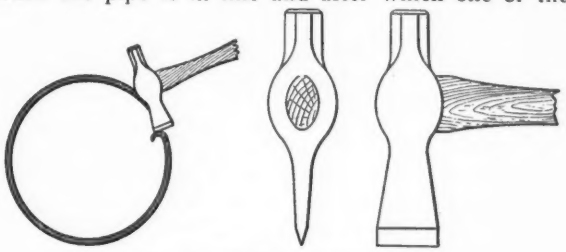


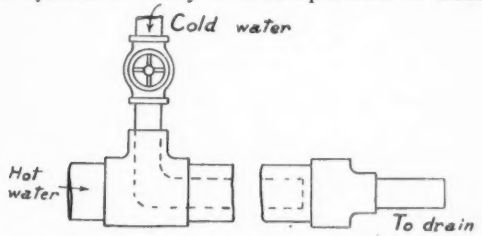
FIG. 4. PIPE-CUTTING TOOL

other is turned around ¼ turn holding the pipe in place. A little jute is then packed at the bottom of the joint and if in a horizontal position an asbestos rope is placed around the pipe and pushed tight against the fitting; a little clay or putty will help. Everything ready, the lead is poured in and the joint is done except for a little calking.

For cutting large size wrought iron or steel pipes out on the job a tool as shown in Fig. 4 used in connection with a sledge hammer is simple and effective; when striking on the cutter it should be held in the position indicated.

COOLING DOWN THE BLOWOFF

Where the blowoff from boilers is carried into the sewer system of a city it is not possible to discharge



it direct from the boiler unless some means be taken to lower the temperature so that no steam will be formed in the sewers. A device suggested by a correspondent in the Engineer-in-Charge will be found of convenience by those who have this problem to deal with. A pipe for cold water is put by means of a T so that it discharges into the blowoff pipe. In one plant where this was used the blowoff pipe was about 30 ft. in length and the cold water connection was made at 3 ft. from the end of the pipe, the hot and cold water mingled being delivered to the sewer by means of a smaller pipe. Of course, the proportion of cold water to hot will depend on the temperature at which the boiler is blown down.

QUESTIONS AND ANSWERS

Our readers are invited to send in their troubles and problems; also to answer questions which are asked. All letters must have name and address of writer, which will not, however, be published. If answers are wanted by mail, send stamp for reply.

Vacuum Effects on Engine Power

How does a vacuum affect the horsepower of an engine? J. H. K.

A.—The horsepower of an engine is found by multiplying the mean effective pressure in the cylinder by the length of stroke in feet by the area of the piston in inches by the number of working strokes a minute and dividing by 33,000. The mean effective pressure is the average difference of pressure between the forward and return strokes, thus by exhausting into a vacuum the pressure during the return stroke is lowered, which increases the difference in pressures and therefore increases the horsepower of the engine.

Boiler Strength; Cast-Iron Column

1.—What is the formula for computing the thickness of boiler plates having given the diameter of the boiler, steam pressure to be carried, tensile strength of the steel, the factor of safety and the per cent efficiency of the joint desired?

2.—How is the supporting strength of a hollow cast-iron column calculated, having given the inside and outside diameters, the length of the column and the factor of safety desired? R. C. S.

A.—To find the thickness of a boiler shell, multiply the pressure in pounds per square inch by the diameter in inches, by the factor of safety and the per cent efficiency of the joint; divide by 2 times the tensile strength of the material.

2.—To find the strength of a hollow, round, cast-iron column divide the length of the column in inches by the diameter in inches, and square the quotient. Divide this by 400 and add the quotient thus obtained to 1. Divide 80,000 by the factor of safety, multiply this by the area of cross section of cast iron in square inches and divide by the sum obtained in the first series of operations. The result will be the safe load in pounds.

Reader Desires Hoisting Engineer's Examination Questions

Will some reader kindly forward to Practical Engineer the questions comprising the written examination for hoisting engineers that were asked at the meeting held at Springfield, Ill., Feb. 15, 1909?

E. H.

Heat Value of Kerosene

About how many gallons of kerosene will give as much heat as 1 ton of good coal? F. W. G.

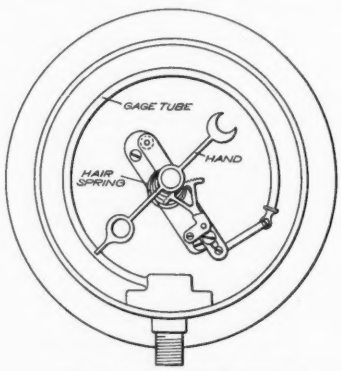
A.—Theoretically about 180 gal. This will vary considerably, depending upon the efficiency of the furnace in which the coal is burned.

Converting a Gage; Equalizing Work in Compound Engine Cylinders

1. How could a low-pressure steam gage be converted into a vacuum gage on the premises?

2. In operating a cross-compound engine we find the high-pressure cylinder is doing 1/3 more work than the low-pressure. How could this be remedied and still run with the greatest economy, or in other words, what would be the most economical way to equalize the work? W. E. C.

A.—It is doubtful if the low pressure steam gage could be converted into a vacuum gage so as to work with any accuracy. In the case of the pressure gage, if it is of the ordinary Bourdon tube type, the pressure tends to uncoil the tube and this, by a clockwork arrangement, operates the gage hand. The converse action of a vacuum would tend to coil up the tube



STEAM GAGE MECHANISM

and push the hand in the other direction, but, of course, standing at zero against the stop pin it could not do this. If the stop pin were taken out the hand could move backwards, and by comparing the gage with a vacuum gage of known accuracy attached to the same line and marking the dial, it would be possible to get an approximate register of vacuum, but we question whether this would be accurate. The accuracy could be tested by repeated comparison of the low-pressure gage with a standard vacuum gage and in this way the constancy of the readings determined.

2. In a cross-compound engine, if the high-pressure cylinder is doing too much work, the cutoff on the low-pressure should be altered so as to raise the back pressure of the high-pressure cylinder. In other words, the cutoff of the low pressure cylinder should be shortened. This raises the initial pressure in the low-pressure cylinder and thereby increases the amount of work done in it.

How to Anneal Bolts

How can iron or steel bolts with finished surfaces be annealed so as not to destroy the finished surfaces and threads? F. J.

Pump Valve Lift

What is the proper lift for a discharge and for a suction valve on a duplex pump 10 by 7 by 2 in., having 2 suction and 2 discharge valves for each plunger, the valves 3 in. in diameter with seat on a bevel of 45 deg., the pump makes 80 ft. piston speed a minute, pumping against 150 lb. pressure; temperature of water 210 deg., and 4 ft. head on the suction side?

J. C. H.

A.—The velocity of water through a valve should not exceed 500 ft. a minute. When the piston speed is 80 ft. a minute and diameter of cylinder 10 in., the lift of a valve with a 3 in. seat, 2 of which are employed to discharge from the cylinder, is found by dividing the product of the area of the cylinder multiplied by the piston speed, by the product of circumference of the valve seat multiplied by 500 and by 2 thus:

$$\frac{10\times10\times0.7854\times80}{3\times3.1416\times500\times2}=0.667 \text{ in.}$$

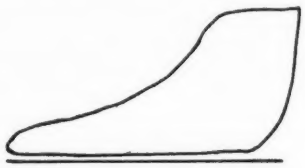
This result is the minimum lift of the valve with a flat seat which multiplied by 1.42 gives the minimum lift for a valve with the seat on a bevel of 45 deg. For the case considered here the valve lift is $0.667\times1.42 = .95$ in.

Ratio of Expansion, Terminal Pressure

H. B. G.—Please tell me if the ratio of expansion and the number of expansions are the same thing. If not, what is the difference?

How can I find the ratio of expansion, the cut off and terminal pressure?

Is the ratio of expansion the same in the cylinders of a compound or triple expansion engine? Suppose



that we have 20 expansions, will there be 10 expansions in each cylinder, and how will it be in a triple expansion engine when there are 3 and sometimes 4 cylinders?

A. 1.—The ratio of expansion and the number of expansions are the same thing. It is the number of times that the steam expands in the cylinder, or the ratio of the final volume to the volume at cut-off.

2. The cut-off can be found only from the indicator diagram, or by watching the action of the engine when turning it over by hand. On the indicator diagram it comes where the curve changes from convex upward to concave upward, as seen on the diagram herewith.

The terminal pressure is found on the indicator diagram by measuring from the atmospheric line as drawn by the indicator up to the point where the exhaust valve opens. Of course, you must know the scale of the indicator spring or number of pounds pressure represented by 1 in. of height in the diagram; then multiply the vertical distance from the atmospheric line up to the point of exhaust opening by the scale of the spring.

3. The ratio of expansion is found by dividing the volume at the end of the stroke by the volume at cut-off, taking into account in both instances the clearance in the cylinder. Or it may be found approximately by dividing the pressure at cut-off by the pressure at the exhaust opening, since the pressure varies inversely as the volume.

4. In a compound engine the ratio of expansion in each cylinder is found in the same way as for a simple engine. The total ratio of expansion for the engine is found by multiplying the ratio of expansion in the high-pressure cylinder by that in the low-pressure; that is, if there are 3 expansions in the high-pressure and 3 in the low-pressure, the total ratio of expansion is 3×3 or 9 if there is no drop in pressure at the end of the high-pressure card.

In a triple expansion engine the total ratio of expansion is found by multiplying together the ratios of expansion for the 3 cylinders. For instance, if there were 20 expansions all together, and there was the same amount of expansion in each cylinder, the ratio expansion in any one cylinder would be the cube root of 20, or if there were 20 expansions in a compound engine the ratio of expansion in each cylinder would be the square root of 20.

There may be either 3 or 4 cylinders in a triple engine; for stationary practice usually 3, but in marine practice there are often 4 cylinders, the steam expanding from the high-pressure to the intermediate, and from the intermediate into the 2 low-pressure cylinders. This arrangement being used to keep down the size of the low-pressure cylinders.

Galvanic Action in Steam Boilers

What is the cause of galvanic action and pitting in steam boilers and what is a good preventive?

C. F. S.

A. Galvanic action is usually due to the setting up of local currents in a boiler because of acid in the feed water. The usual remedy is to hang zinc plates in the boiler, but precaution should be taken to have a secure contact between the zinc and the iron of the boiler. When this is done the zinc will be attacked instead of the iron of the boiler and will gradually be eaten away. These zinc plates should be suspended near the entrance of the feed and should be renewed whenever they have been converted into zinc oxide so that they are brittle and have an earthy fracture.

With regard to the matter of pitting in steam boilers, refer to the January issue, Page 3.

THE ELLIOTT MECHANICAL STOKER.

New and different methods of handling coal are embodied in this device, many of them being features which have not heretofore been embodied in any stoker. The operations which the mechanism performs are: First, the crushing of the coal and regulating the amount fed; second, feeding the coal at the top of the grates, which are inclined 16 deg. from the side toward the center; third, moving this coal downward, as it burns, toward the center of the grate and at the same time removing ash as it forms; fourth, dumping the ash remaining at the bottom of the grate into the ashpit; fifth, scraping all the ash towards the center of the ashpit; sixth, removing all ash by means of a screw conveyor.

Figure 1 shows the operating mechanism on the front of the stoker, the right-hand apparatus having the covers and casings removed to show all the working parts and driving mechanism and the left-hand stoker having the casings and covers complete as in operation to protect the parts from the coal dust in the boiler room. Coal is fed into a hopper at the center of the boiler front and, passing downward through the crushing rolls is pulverized and falls to the screw conveyors just below. By these screw conveyors it is carried to the right and left where it is delivered by blowers through tunnel blocks upon the highest points of the grates throughout their length; by building these tunnel blocks in the side walls the entire area of grate surface is preserved.

Power for driving is taken from a main shaft which runs across the boiler front and which is always running while the battery is in operation. Each stoker is coupled to this shaft by a friction clutch or thrown out as may be desired. The rate of crushing and feeding the coal is regulated by means of a series of change gears shown just to the right of the crusher in the right-hand stoker of Fig. 1. Power for the blowers and screw conveyors is taken from the main shaft by a silent chain and sprocket mechanism and power for rocking the grate and for operating the ash scraping device is taken from the main shaft through bevel gears and by means of a clutch mechanism, shown on the right-hand stoker disconnected and on the left-hand stoker connected. The upper pair of screw gears in the bottom casing is used to operate the grate rocking mechanism and the lower pair to drive a set of sprocket wheels which carry the scraper chains, for scraping ash the entire length of the furnace to the center conveyor screw.

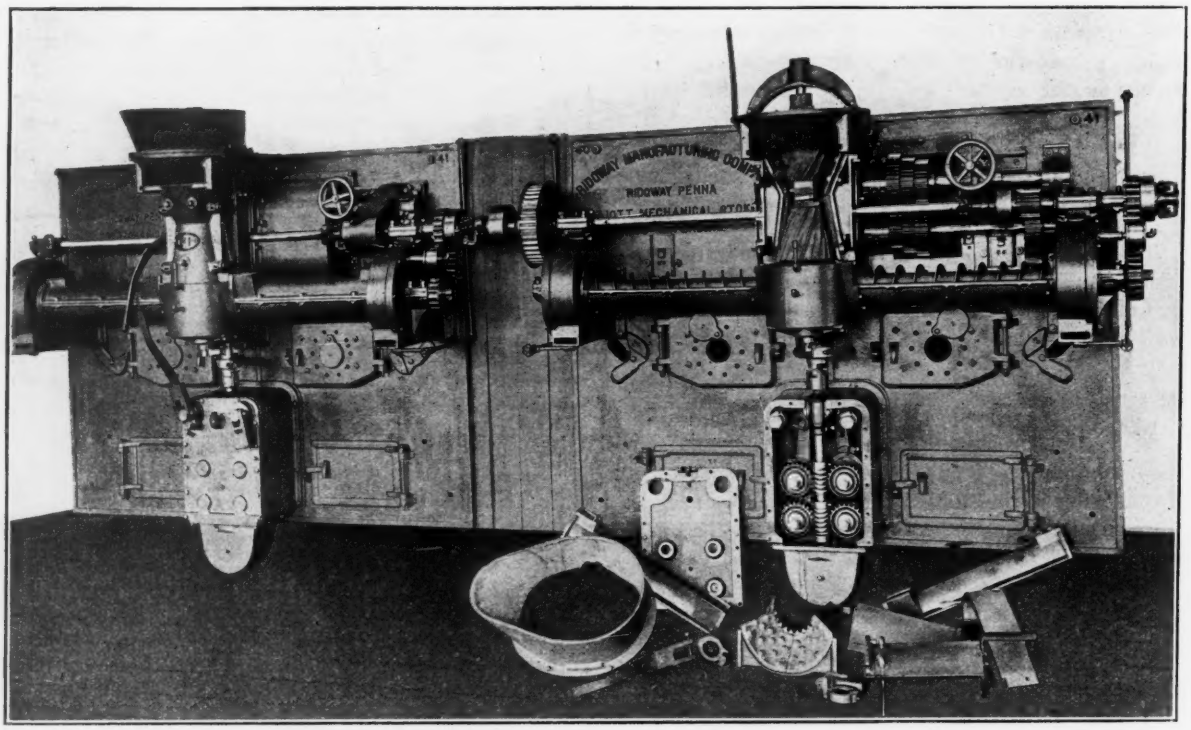


FIG. 1. OPERATING MECHANISM OF ELLIOTT STOKER

Figure 2 shows the rear view of the stoker, the tunnel blocks through which the pulverized fuel is discharged to the grate being seen on the back of the boiler front. The arrangement of perforated grates is clearly shown and also, where part of the grate bars are removed, the device which catches an arm on the bottom of each grate bar and rocks the bars sidewise. At the bottom of the grate are the dumping bars which rock with the other bars when not being dumped and which are dumped by the lever seen on the front of the stoker in Fig. 1. After they have been

dumped and returned to position, these bars continue rocking with the rest of the grate as before.

Below the grate bars in Fig. 2 are seen the chains and scrapers which carry the ash from the sides of the ashpit to the center and also the screw conveyor which takes it from the ashpit to the front end where it drops through a tunnel. The cement floor of the ashpit is built at a slight angle inclining toward the center and the scraper irons carried by the chains at each end drag along this floor drawing the ash to the center, keeping the floor of ashpit clear of ash at all times.

Figure 3 shows the top and bottom views of the grate bars indicating clearly the perforations, the form of the bars by means of which they intermesh with each other, and the distribution of metal which relieves strains and prevents heating so that there is no warping or twisting. The success of this grate bar design

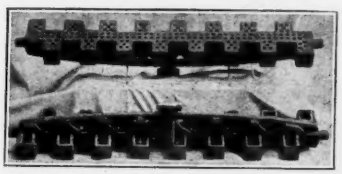


FIG. 3. TOP AND BOTTOM VIEWS OF GRATE BARS

is proved by the fact that a set of these grates has been operated for 2.5 yr. without replacing a single bar and that the grates were finally taken out to to be replaced only because of redesigning of the stoker and change of the means of rocking the grate. No pins, bolts or spring cotters are used in the manipulation of the grate bars or in putting them in place so that there is nothing in the grate itself to get out of order.

By reference to Figs. 1 and 2 it will be seen that at any time it is desirable to hand feed the boilers, the stoker can be stopped, the fire doors opened and hand feeding commenced with no change whatever in the setting and without removal of the stoker. Furthermore, the stoker will not be in the way as the mechanism is so compact that it projects only 20 in. in front of the boilers.

Figure 4 shows an installation of the stokers that has been in use for 2 yr. and is still operating without repairs. The installation as shown is motor-driven, but a small engine can be used where desired, and either motor or engine can be placed at any convenient point in the boiler room. Usually a motor or engine drives from 1 to 4 stokers.

Tests on the power used by the stoker give for the size shown that 2 stokers require only 3.66 hp. when in full operation.

Natural draft has been found to work better in the Elliott stoker than forced draft, so that there is no occasion for additional mechanism in this respect. Peep holes are provided in the boiler front so that it is not necessary to open the doors to find out the condition of the fire either when operating the stoker or when hand firing. The crusher may be run while the grates are standing still or the grates may be operated with the crusher standing still, so that it is possible to use the stoker for the banking of the fires at the end of the day's run by stopping the grate action, or the rocking grate can be used while being hand fired.

Evidently, by crushing the coal to a fine and even size and by distributing it evenly with the fan, the best possible condition for complete burning is secured, and that this is so is proved by the fact that the fuel is burned entirely to ash in this stoker.

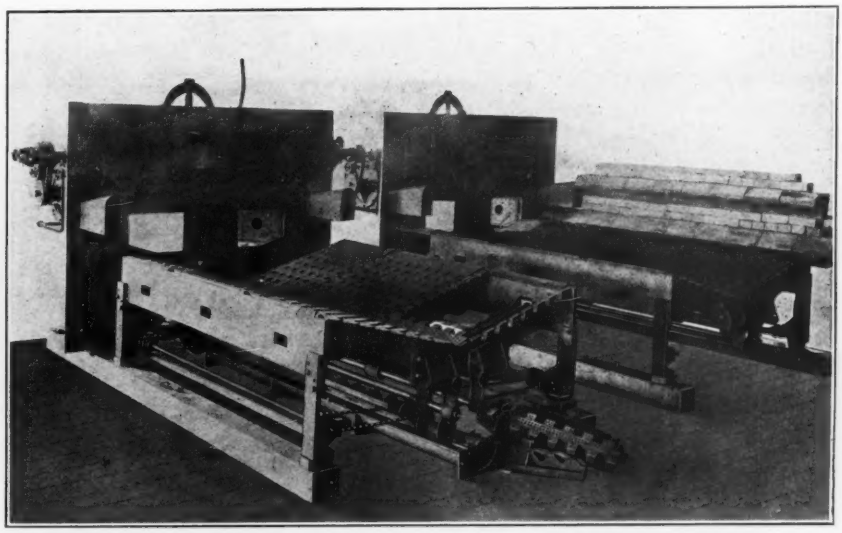


FIG. 2. REAR VIEW OF STOKER SHOWING ARRANGEMENT OF GRATE

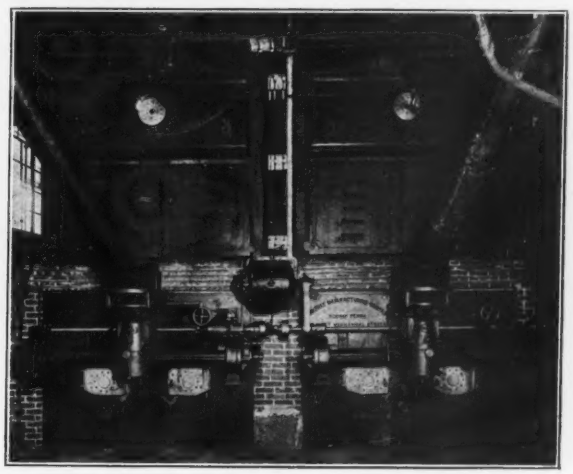


FIG. 4. ELLIOTT STOKERS DRIVEN BY MOTOR

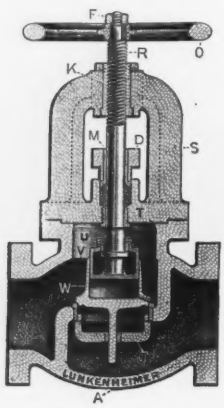
The Elliott stoker is manufactured by the Ridgway Manufacturing Co., of Ridgway, Pa.

LUNKENHEIMER NONRETURN BOILER STOP VALVE

The necessity for a reliable nonreturn stop valve on each boiler when several are operated together, is now universally recognized, and in some countries their installation is required by law.

When several boilers are connected to a common header, it is evident that, if a tube is blown out or a fitting ruptured, the steam from the battery of boilers will rush into the header and discharge through the boiler which is disabled. The difficulty of closing a stop valve in the event of such an accident is apparent. The Lunkenheimer Co., of Cincinnati, Ohio, has designed a nonreturn boiler stop valve, which it claims entirely overcomes this danger. This valve is intended to be placed between the boiler and header.

Such a valve on a boiler prevents steam being turned into it when it has been cut out for cleaning or repairs, or for the reason that the valve cannot be opened by hand. It can, however, be closed by hand the same as any other stop valve.



THE LUNKENHEIMER NON-RETURN STOP VALVE

In the Lunkenheimer valves the areas are large and free. The internal dashpot and piston prevent chattering of the disk; all wearing parts are made of bronze and the gland and stuffingbox are bronze bushed. For superheated steam work, these valves are made of puddled semi-steel with nickel trimmings and nickel-steel stems.

They are made in sizes from 4 to 10 in. inclusive, and can be furnished with screw or flange ends.

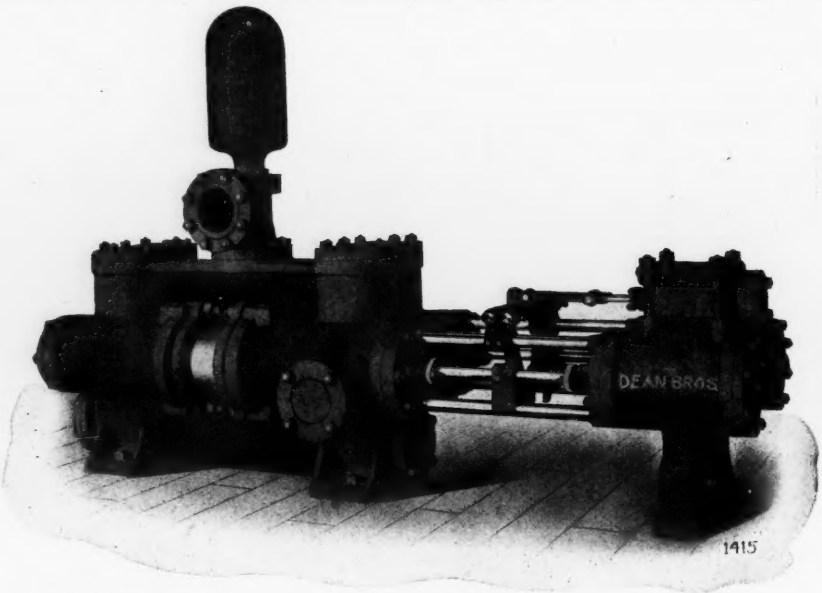
SINGLE BELT 0.16 in. thick at a strain of 33 lb. a sq. in. will need to run at 625 ft. a minute to give 1 hp. for each inch of width. Light double belt must run at 417 ft.; medium double belt at 357 ft.; standard double belt at 303 ft. and 3-ply belt at 222 ft.

DEAN BROS. DURABLE DUPLEX PLUNGER PUMP

Both steam and water ends of this duplex pump are of new design, the effort having been to produce a pump that will stand long service working against heavy pressure. The convenience of the engineer has been carefully looked after; all nuts are easily accessible and all parts can be removed and replaced with the least possible trouble. The steam cylinders are of a new type with steam ports arranged on a novel plan. The method of steam cushioning is new, and the valves are of an original form.

The most serious objection to duplex pumps, making short strokes which use the full amount of steam but only deliver half the capacity of water, has been overcome and this pump will always make full stroke which stroke is unusually long.

The water end of this pump is a compact form of outside, center packed, plunger,—a new and improved design for feeding boilers, pumping against high pressures, etc., and for either hot or cold liquids. There are several advantages in this manner of packing. No leak can occur without being observed, and it can easily be stopped by setting up the packing. The plungers not touching the pump castings, will not cut or wear, consequently require no refitting.



DEAN BROS. DUPLEX OUTSIDE CENTER PACKED PLUNGER PUMP

The suction pipe opening is at the end of pump, and the discharge pipe opening may be turned in any direction.

These pumps are made by Dean Bros. Steam Pump Works, Indianapolis, Indiana.

INSPECTION OF THE Westinghouse turbines in the street railway plant at Easthampton, Mass., from time to time during a period of 2.5 yr. shows no signs of wear or corrosion on the blades, and the entire machine is in excellent condition.

THE HARRIS SMOKELESS FURNACE

For burning slack or low grade soft coal with good efficiency in steam raising, various schemes and devices have been tried, some of which have been reasonably successful, others absolute failures. The necessary conditions are well understood, but to meet these conditions is a problem which has baffled many inventors.

In the Harris Furnace, which was invented and patented by John B. Harris of Nashville, Tenn., and which is manufactured by the Harris Smokeless Furnace Co. of that city, it has been found possible to burn soft coal, slack, sawdust, and other cheap fuels with the best of results in raising steam and without producing smoke. For those cities which are cursed with the soft coal atmosphere, the introduction of this furnace into the boiler plants of the city will mean a blessed relief.

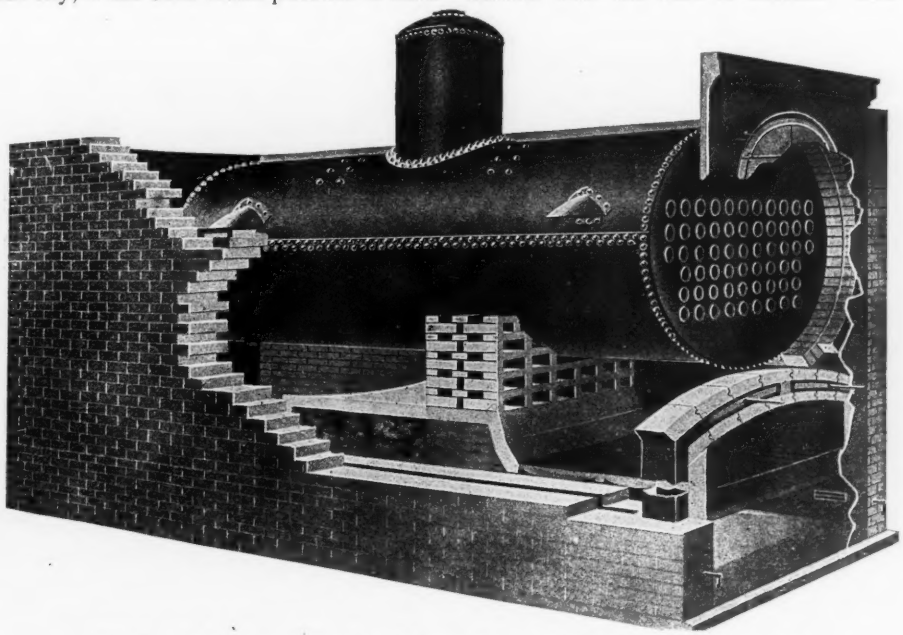


FIG. 1. THE HARRIS FURNACE UNDER A FLUSH FRONT TUBULAR BOILER

The Harris Furnace has been in use long enough to be long since past the experimental stage and many users give extremely complimentary reports of the working of these furnaces. The special features are indicated quite well in Figs. 1 and 2, the first of which shows the application to a return tubular boiler with flush front and the second application to an Erie City Iron Works water-tube boiler. High heat, with a complete mixture of air and gas and sufficient time while still at high temperature to insure perfect combustion, are the essentials of smokeless burning and these conditions the furnace is designed to furnish.

The furnace consists of a fire-box and several concentric spaced arches at the front of the box, these arches containing steam blowing nozzles which draw air from the ash pit and force it in on top of the bed of fuel. On top of the bridge wall is a checker work of fire brick and extending back of the bridge wall an arch which holds the gases comparatively close to the boiler shell. The same essential features are found in the setting for water-tube boilers. The completeness of combustion is shown by the fact that where shavings, sawdust and chips are used as fuel, there is no necessity to muzzle the top of the stack with wire gauze to prevent the escape of sparks.

The test of any device is its performance in actual operation. In different parts of the country such fuels as slack, soft coal, peanut hulls and sawdust have been burned with the best of success. The testimony of users is that the furnace will "prevent smoke from the worst coal," "steam our boilers from a lower grade of coal than we could do with old style furnace settings," "the device is in every respect superior to everything we have seen in the elimination of smoke." Such evidence is sufficient proof of the merit of the furnace.

IN THE CIRCUIT COURT of Milwaukee, Judge Turner enjoins the Dornfeld-Kunert Company, J. F. Dornfeld and C. J. Atkinson from advertising, selling or offering for sale, gas producers named or designed "Atkinson Gas Producers"; that they must clearly indicate the machine sold by them is not the "Atkinson Gas Producer" manufactured and sold by the plaintiff, the Industrial Gas Power Co.

A NEW COMPOSITION OR PAINT for protecting stone, wood, cement, etc., from the effects of damp or other deleterious influences consists of quicklime, chalk, mineral colors, turpentine, boiled oil, galipot, rosin, and benzine. The lime, chalk, colors, and turpentine are first mixed and then made into a paste with the boiled oil. The paste is finely ground and mixed with the rosins previously dissolved in the benzine.

AN IMPROVED SYSTEM FOR BURNING CRUDE OIL

In any system for oil burning, the most important detail is the burner, hence in the Nelson system the burner has been carefully designed not only to give perfect combustion but to do away with complications.

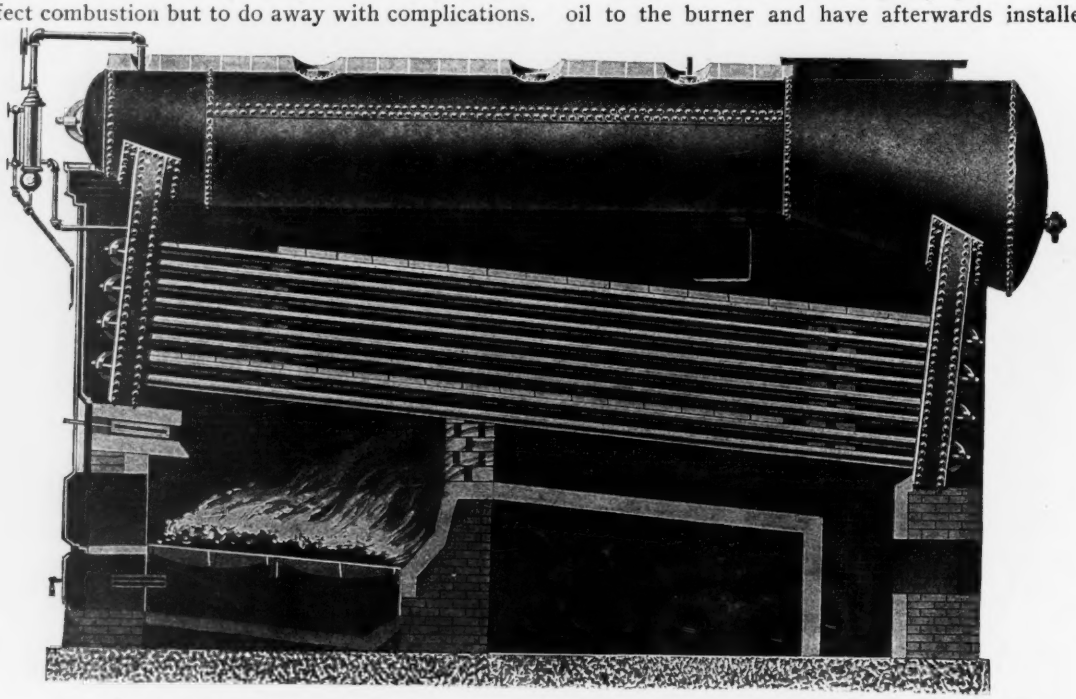


FIG. 2. INSTALLATION OF HARRIS FURNACE UNDER ERIE CITY IRON WORKS WATER-TUBE BOILER

The injector principle is embodied in the burner, the steam which atomizes the oil, also creating a partial vacuum, within the suction line, leading from the oil supply to the burner.

The only parts to the Nelson system are the burner, the oil storage tank and the necessary piping, no pumps being used. The partial vacuum created in the suction line draws all air from it and also draws oil into the burner whence it is carried through the burner at a high velocity by the steam, thoroughly atomized and discharged into the furnace. The steam connection to the burner is from the top and the oil connection from the bottom.

The amount of steam used is regulated by the needle valve, controlled by the handle at the rear of the burner and the amount of steam used controls the amount of oil supplied so that the 2 are always properly proportioned. A small steam jet is provided below the main discharge nozzle for the purpose of thoroughly distributing the atomized oil over the burning area. Provisions are made for delivering all steam to the burner in a highly superheated condition.

Those who have used the pump system for forcing oil to the burner and have afterwards installed the Nelson burner are unanimous in saying that the Nelson system is far superior to any pump system. It has made savings as high as 13.8 per cent in the amount of oil used and works satisfactorily with a suction pipe 100 ft. long and 15 ft. lift. Advantages of the system are: The absence of oil pumps, pressure tank and auxiliaries; low steam consumption; oil not under pressure; free from mechanical complications; when steam is shut off the flow of oil stops: low first cost.

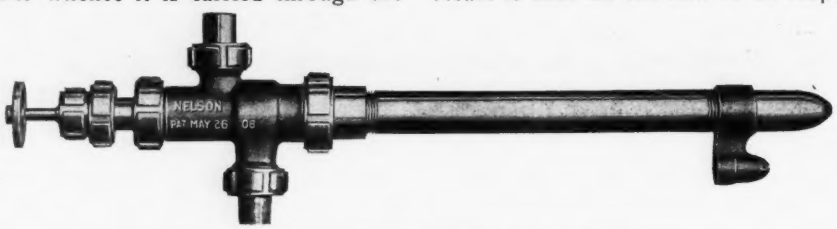


FIG. 1. THE NELSON CRUDE OIL BURNER

The life of the system is practically unlimited and the repair account is eliminated.

The Nelson burner is manufactured by R. C. Nelson, Healdsburg, California.

"GOOD OAK TANNED LEATHER from the back of the hide weighs almost exactly 1 oz. avoidupois for 1 ft. square and 0.01 in. thick."

THE SIMS OIL FILTERS

No question is now raised as to the merits of oil filters as part of the engine room, equipment their function of removing impurities from the oil being regarded as essential in order to reduce the oil bills. In designing the Sims filters, 3 important features have been considered: first, the method of removing impurities; second, the cost, and third, time required for thorough cleaning.

The filters are made in 2 patterns, one the single filter, called Style A, the other the duplex type which is made up for larger units. The filters are made of the best grade of galvanized sheet iron with double lap joints, well braced, riveted and soldered. The unit type, shown in Fig. 1, is made up in round form with a partition through the center, while the duplex type, which is square in form, has 2 or more partitions, according to size. The object of the partion in each case is to separate the clear oil from that under process of treatment, so that the clear oil is not disturbed when the filtering section is being cleaned.

Referring to the illustrations, the filtering section consists of a tank, A, having connected to it a tube with cone deflectors. Attached to the bottom of tank A is a cylinder of coarse mesh wire screen, G, covered with suitable filtering material, H. Oil must pass through this filtering material on its way to the clean oil section. Dirty oil is poured into the perforated bucket placed inside the tank, A, and will descend through the settling tube to the bottom of the filtering chamber.

It will then rise through the perforation, C, and gather on the cone, D, from which it will slide upward, passing to the inside of cone E, which is larger in diameter than D. It will pass upward through perforations in the cone E, and gather on the cone F, from the surface of which it passes upward to the oil floating on the surface of the water. The water is poured into the filtering chamber when starting operations to the level indicated on the sectional views. After reaching the surface of the water the oil passes through the filtering cloth slowly, giving time for perfect separation of impurities.

When oil reaches the level of the faucet, I, it will flow over into the clean oil chamber and is ready to be

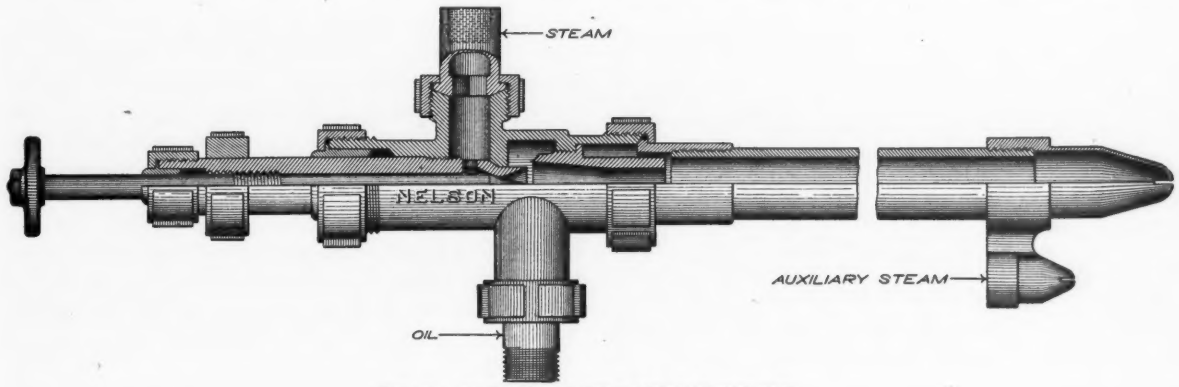


FIG. 2. SECTION OF THE NELSON BURNER

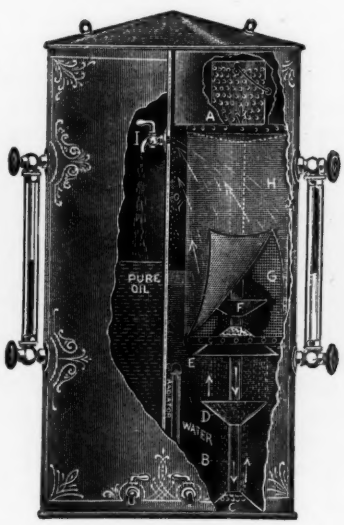


FIG. 1. THE SIMS SINGLE FILTER

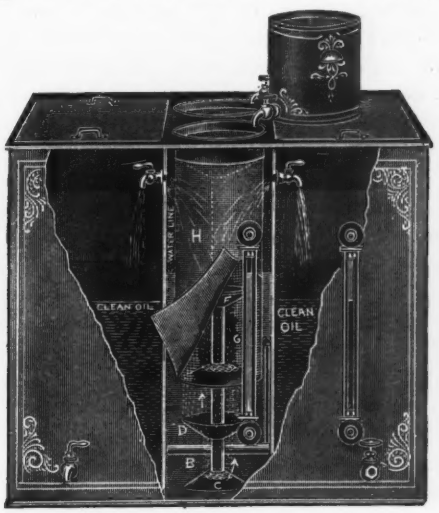


FIG. 2. SIMS DUPLEX OIL FILTER IN SECTION

taken out and used over again. The Sims Co. makes, as well as the 2 types of filters, a continuous oiling system, of which the filter forms a part.

In order to clean the filtering chamber the inner structure of the filtering section is removed and the filtering cloth taken off and washed carefully, the cylinder cleaned, cones and pipe scrubbed and all oil and dirty water carefully rinsed off. The water is then taken out of the filtering chamber, the surfaces of the chamber cleaned thoroughly, the cloth replaced on the cylinder, the filtering section put back and the chamber filled with water to the proper level. Sizes are made in the unit filter with capacity of from 3 to 50 gal. of oil a day, and in the duplex type with capacities of from 100 to 600 gal. a day. The filters are manufactured by the Sims Co., Erie, Pa.

A RARE OPPORTUNITY

Seldom is there a chance to get from power stations such a variety of modern and little used machinery as is now available in Chicago, and still more rarely is it possible to get the pick of 3 large station equipments by dealing with one firm.

Recently the Chicago City Railway Co. arranged to take all its power from the Edison central stations, putting its own power plants out of commission. These were 3 in number, one at 49th St. and Oakley Ave., one at 21st and Dearborn Sts., and the third at 52nd St. and Wabash Ave. The machinery is such as would be found in any modern railway power plant, Wheelock engines, 550-volt d. c. generators, water-tube boilers, stokers, heaters, pumps, switchboards and other apparatus. Two of the plants are still in full operation so that the actual working of the machinery can be seen. All have been kept in the best of repair.

The throwing of such a mass of fine machinery into the market is remarkable; that one firm stood ready to handle it all is more remarkable. The Chicago House Wrecking Co. has taken over the entire outfit so that it is possible to select any complete generating outfit or any combination of outfits, or any single piece of apparatus as may be desired. And, of course, being used machinery, although in the best of condition, a substantial saving can be made over the cost of new equipment.

SHAFTING LUBRICATION

The effective and economical lubrication of line shafting is of great importance for the reason that in plants where lax conditions prevail the friction loss in shafting may amount to a large proportion of the total power. In the nature of things the lubrication of shafting is liable to be neglected in many mills and factories; and this fact accounts for the high average friction loss—estimated by the late Professor R. H. Thurston to be 50 per cent.

It is claimed that the grease, which is a natural petroleum product made by the Keystone Lubricating Co., of Philadelphia, practically revolutionizes shafting lubrication by reducing the friction to a low and constant figure, vastly reducing the cost and insuring immunity from damage to stock caused by the dripping and "throwing" to which lubricating oil and ordinary greases are liable. Not only does this lubricant remain in the bearing where it belongs, but it also seals the bearing effectually against the entrance of grit or other foreign matter that might be in the air.

For example, No. 4 density Keystone grease is used with perfect satisfaction in the 2 plants of the Atlantic Terra-Cotta Co. at Tottenville, S. I., and in the works of the Sayre & Fischer Co. at Sayreville, N. J., which stand in the front rank in the manufacture of fire-brick and common brick. In these plants conditions are especially adverse to the maintaining of good shafting lubrication, the air being full of fine clay-dust, which ordinarily causes continual trouble in bearings. The grease used thoroughly permeates the bearing, but does not creep out on the shafting or drip from the box. It remains in the bearing where it belongs.

WHEN SHAFTS ARE PARALLEL and the pulleys not directly opposite, the belt will run more to one side than the other of the large pulley; if the pulleys are opposite and the shafts not parallel, the belt will run to one side of the small pulley.

HONOR TO CHARLES T. PORTER

On the 13th of April a meeting was held in the Engineering Societies Building, in New York, at which the John Fritz medal for conspicuous achievement in engineering work was presented to Charles T. Porter, the originator of the modern high-speed engine. Addresses were made by Dean W. F. M. Goss, of the University of Illinois, on the Debt of Modern Industrial Civilization to the Steam Engine, by Prof. F. R. Hutton, on the Debt of the Modern Steam Engine to Charles F. Porter, by Capt. R. W. Hunt, of Chicago, on the Debt of the Era of Steel to the High Speed Engine, by Frank J. Sprague, of New York, on the Debt of Electricity to the High Speed Steam Engine. The awards of this medal, which have been made heretofore, were: for 1905, Lord Kelvin; 1906, George F. Westinghouse; 1907, Alexander Graham Bell; 1908, Thomas A. Edison. The medal was established by the friends of John Fritz, of Bethlehem, Pa., in 1902, on his 80th birthday to perpetuate his achievements in industrial progress.

At the presentation, Dean Goss outlined the accomplishments of steam in draining mines, in moving merchandise, in making possible large, commodious factories and in relieving human muscle from drudgery.

In speaking of Mr. Porter's work, Prof. Hutton said that the debt might be grouped under 5 heads, first, the idea of running the crankshaft at a high number of revolutions, thus reducing the weight of the engine per horsepower, from which has come the modern design of engine for the automobile and the aero-

plane; the second debt is for Mr. Porter's recognition of the problems involved in this high speed and the solution of the requirements for starting and stopping heavy parts in each revolution. The third debt was for raising the standard of mechanical construction in the high-speed engine to the highest type, developing many manufacturing details unknown before his early work, but which now are considered commonplace. The fourth debt was for the creation of a steam engine condenser which could be attached directly to the engine and operated at a higher rate of speed than an ordinary pump, and the fifth debt for a sensitive steam engine governor which has been perfected in two forms.

Prof. Hutton also mentioned the work of Prof. Chas. B. Richards and of John Allen, who were associated with Mr. Porter and who conceived many of the details which Mr. Porter combined into a complete machine.

Speaking of the expansion in the steel industry, Mr. Hunt said that the inconceivable developments which had been accomplished since the invention of the Bessemer process were made possible by a rapid power. When the engine was first attached directly to the roll train in steel work the speed was slow because the engine was a slow-speed engine. Mr. Porter gave a high speed rolling mill engine which could be controlled and was economical. A notable contrast of this kind in a rolling mill plant in Troy, N. Y., in 1876, was mentioned, where one set of rolls was driven by an old beam steamboat engine at low pressure, running from 35 to 40 r. p. m. Another set of rolls was driven by Porter-Allen engines buzzing away at our common high speeds.

Mr. Sprague mentioned in detail the engines first exhibited by Mr. Porter at Paris, in 1867, driving generators for supplying current, these engines being about the same that are now ordinarily used in isolated lighting plants. Later engines were built for Mr. Edison in his laboratory, and shortly after for the Edison Station in Pearl Street, New York. The high-speed engine and the dynamo have gone hand in hand in developing the lighting industry, but the small lighting unit would be impossible without the high-speed engine which Mr. Porter gave to the world.

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The American Society of Mechanical Engineers will hold its spring meeting in Washington, D. C., May 4-7. Professional sessions will be held at which papers on the conveying of materials, gas power engineering, steam turbines, the specific volume of saturated steam, oil well pumping and various other subjects will be discussed.

At the reception, which will be held in the new Willard Hotel, an address of welcome will be made by B. F. Macfarland, president of the Board of District Commissioners, with a response by Jesse M. Smith, president of the Society.

During the convention President Taft will hold a reception for the members at the White House. The War Department will give a special exhibition drill of the U. S. troops at Fort Myer, to which the members and guests will be invited. At the same time, if the conditions are favorable, an ascension of a dirigible balloon will be made and probably also one of an aeroplane.

An address will be given by Rear-Admiral Melville, retired past-president of the Society, and former engineer-in-chief of the navy, the subject being The Engineer in the Navy. This evening will be made the occasion for the presentation to the National Gallery of a portrait of Rear-Admiral Melville by friends and admirers. It will be received for the National Gallery by Dr. C. D. Walcott, secretary of the Smithsonian Institution.

F. H. Newell, director of the Reclamation Service, will deliver an illustrated address on Home Making in the Arid Regions. Trips will be made to various points of interest about the city and a number of pleasurable excursions have been planned.

The papers to be presented are as follows: A Unique Belt Conveyor, Ellis C. Soper; Automatic Feeders for Handling Material in Bulk, C. Kemble Baldwin; A New Transmission Dynamometer, Prof. Wm. H. Kenerson; Polishing Metals for Examination with the Microscope, A. Kingsbury; Marine Producer Gas Power, C. L. Straub; Operating System for a Small Producer Gas Power Plant, C. W. Obert; A Method of Improving the Efficiency of Gas Engines, T. E. Butterfield; Offsetting Cylinders in Single-Acting Engines, Prof. T. M. Phetteplace; Small Steam Turbines, Geo. A. Orrok; Oil Well Tests, Edmund M. Ivens; Safety Valve Discussion; Specific Volume of Saturated Steam, Prof. C. H. Peabody; Some Properties of Steam, Prof. R. C. H. Heck; A New Departure in Flexible Staybolts, H. V. Wille.

NEWS NOTES

LINTHICUM, BELT & FULLER is the firm name in a partnership for the practice of patent law formed by Messrs. C. C. Linthicum, William O. Belt, and Walter M. Fuller. The office is in Rooms 731 to 736 Monadnock Block, Chicago.

AT THE UNIVERSITY OF WISCONSIN, Madison, during the week of March 22, 3 special lectures were given for the benefit of the students by men outside the college faculty. The first was by W. D. Taylor, chief engineer of the Chicago & Alton Railroad, on the Duties and Responsibilities of the Engineer; the second, by M. C. Rorty, general commercial superintendent of the Pittsburg Telegraph Co., on Major and Minor Tactics of Business; the third, by Prof. C. F. Burgess, on the Importance of Chemistry to Future Engineering Development.

IN AN ADDRESS delivered before the Illinois Fuel Conference, Professor L. P. Breckenridge gave an account of the work of the engineering experiment station at the University of Illinois and what it has accomplished. The station was established in 1903, answering a demand from the industrial interests of the state, to investigate problems as to transportation, fuel economy, and manufacturing. It was planned to do for its field what the agricultural experiment stations were doing for theirs. The university teaching staff direct and they and the advanced students carry out the investigations. Twenty-five reports have so far been published and from 5,000 to 20,000 of each distributed.

Future work will be extended to cover perfection of machinery, prevention of waste, safeguarding of life, and surer sanitation.

E. H. STEVENS, who is well known among steam power plant and central station men, as the general superintendent of plants of the Public Service Corporation

of New Jersey, has resigned that position to become vice-president and general manager of The Bird-Archer Co., 90 West St., New York.

During his 15 yr. experience in power plant operation costs and management, Mr. Stevens has had complete charge of plants aggregating several hundred thousand

E. H. STEVENS.

horsepower, and is therefore exceptionally well prepared to deal with questions about feed water treatment. His genial disposition, courtesy and engineering ability have won for him the respect and esteem of all with whom he has come in contact, and his many friends wish him all success in his new work.

THE CHICAGO OFFICE of Schaeffer & Budenberg has been removed to 339 Dearborn St., where a full stock of instruments for testing engines, boilers and other steam apparatus will be carried.

ON MAY 5 EXAMINATION will be held in various cities of the country for Mechanical Assistant in the Department of Agriculture. The salary is from $900 to $1,200 a year and the duties the operation of a special railway car equipped with refrigerating machinery. The equipment will be a 12-ton Remington ammonia compressor, belt-driven by 30-hp. Secor oil engine, with 45-in. exhaust fan for ventilation of the car, plunger pump and centrifugal brine pump. The examination will consist of questions as to the care and operation of machinery in general, especially gas engines and refrigerating machinery, and on experience in handling steam or other machinery of the kind specified above. Age limit is 25 yr. or over, examination open to all citizens of the United States. Applicants should apply to the U. S. Civil Service Commission, Washington, for Form 1,093, or can apply to the secretary of the examining board in any of the larger cities throughout the country.

C. G. HAFLEY, formerly advertising manager for the Buffalo Forge Co., Buffalo, N. Y., and more recently with Keuffel & Esser Co., Hoboken, N. J., has taken a position with the Vechten Waring Co., 92 John St., as assistant to Mr. Waring in the advertising service department.

W. L. Ross has been elected vice-president of the Chicago & Alton Railroad Co. and of the Toledo, St. Louis & Western Railroad Co., in charge of the traffic of these 2 companies, and E. S. Worthan has been appointed as assistant.

W. J. BOWEN & SON, Nashua, Iowa, have recently purchased the water power at Janesville, Iowa, and will erect a 250-ft. dam and power house, the dam to be 15 ft. high. They are open for bids on the development of the power and construction of the plant complete.

MESTA MACHINE CO., Pittsburg, Pa., entertained the Engineers' Society of Western Pennsylvania at its works on Saturday afternoon, March 27. A special train left the Union Station, Pittsburg, at 2 o'clock, arriving at the works at West Homestead at 2:20, when the engineers were taken for an inspection of the fireproof office building, then through the machine department where a 36 by 72-in. Corliss engine was in course of erection, a blast furnace blowing engine with steam and air cylinders 84 in. in diameter and 60-in. stroke, and machinery for a 600-ton metal mixer double the size of the largest now in use. The trip continued through the roll foundry department where casting of water chilled rolls was in progress, through the steel foundry department, where a heat of 60,000 lb. was poured, through the new foundry department where the casting of a 160,000-lb. engine bed plate was seen, and then to the basement of the new pattern shop where luncheon was served. The party returned to Pittsburg on a special train at 5:30.

KOMO STEAM TRAPS are now sold in the New York territory by the Linton Machine Co., 26 Cortlandt St. P. A. Moulton, who has been sales agent for the trap, will be the manager of the steam trap department for the Linton company.

STANDARD ELECTRIC ACCUMULATOR CO., of New Jersey, has removed its office to 91 Mercer St., New York.

THE CLEVELAND INDUSTRIAL EXPOSITION, which is to be held June 7-19, at Cleveland, O., is being rapidly prepared for. An exposition building having a floor area of 57,000 sq. ft. is being erected. Reduced rates of fare have been secured on the railroads and over 240 firms have arranged to make exhibits.

THE OFFICE OF THE DUBOIS IRON WORKS, formerly located at 1206 Park Bldg., Pittsburg, Pa., has been removed to 1429 Park Bldg., to give more commodious quarters. G. E. Webb, who has been in charge of the office, remains in that position.

BUCKEYE ENGINE CO., of Salem, Ohio, has opened offices for the handling of Western trade at Kansas City, Mo., 504 New York Life Building, in charge of Louis Bendit, and at Wichita, Kan., 505 Barnes Bldg., in charge of J. R. Detweiler. The Buckeye company has had a successful engineering experience of over 62 yr. in steam and gas power equipment and builds gas engines suitable for natural or producer gas in sizes up to 5,000 hp. and steam engines in any style up to 8,000 hp.

THE LAWSON MFG. CO., of Buffalo, N. Y., has removed to new quarters at 379 Main street.

THE FIRM FORMERLY KNOWN as the Ideal Automatic Pump Governor Co. has changed its name to the Ideal Automatic Mfg. Co., and has been incorporated under the laws of the State of New York, the office being at 125 Watts street, New York City.

AIR COMPRESSOR LUBRICATION

There is always a lurking danger where oils are used for lubricating air compressor cylinders, especially where the poorer grades of oil are employed. Many disastrous accidents have been traced to the re-

ceiver or pipe line explosion caused by the vaporization of lubricating oils. These vapors uniting with the air form a violent explosive mixture. There is also apt to be more or less trouble from the formation of hard carbon deposits. Instances are on record where it has been necessary to shut down and chisel the carbon deposit off the piston and relief valve.

By using Dixon's flake graphite and oil fed by means of a graphoil lubricator troubles with carbon deposits and dangers of explosion are reduced to a minimum. Some concerns have advised the Dixon Co. that instead of oil they have used soapsuds with flake graphite and have secured perfectly satisfactory results.

It is suggested that you put a small quantity of Dixon's flake graphite No. 635 with the oil into the hand oil pump on the steam line. A little of the mixture can then be conveniently supplied at various times.

The booklet "Air Compressor Lubrication" published by the Joseph Dixon Crucible Co., of Jersey City, N. J., contains much valuable information on the subject of air compressor lubrication besides suggestions for the best ways to feed the graphite. This booklet will be gladly sent to those interested who will write direct to the Dixon Co.

BOOKS AND CATALOGS

STANDARD ELECTRIC TIME SYSTEMS as used for industrial plants are described in Bulletin No. 22 issued by the Industrial Instrument Co., Foxboro, Mass. This bulletin shows the clocks used for different systems, the method by which a program clock such as is used for controlling the schedule of schools operates to give its signals. The wiring circuit necessary for controlling the secondary clocks and bell signals from a master clock and the general uses for time stamps in industrial works.

CATALOG 5, SECTION B, issued by Schutte & Koerting Co., of Philadelphia, shows the construction of its Multi-Jet Eductor Condenser, which is for use without an air pump and to take the place of the ordinary barometric condenser.

DEAN BROTHERS STEAM PUMP WORKS, of Indianapolis, Ind., sends out at frequent intervals interesting folders showing its different styles of steam pumps. One just received shows the duplex durable pump having a new style of steam cylinders and with a different arrangement of steam ports, also an original form of valve and a new method of steam cushioning. Another view shows the Dean Brothers simple stroke which are long stroke pumps of the simplest possible form.

ROCHESTER AUTOMATIC LUBRICATORS of the latest improved type are described in a booklet issued by Greene, Tweed & Co., 109 Duane St., New York. This shows the arrangement of the Rochester lubricators, the improved vacuum and check valve, and the multiplus sight feed.

CURTIS ENGINEERING SPECIALTIES, manufactured by Julian d'Este Co., 24 Canal St., Boston, Mass., include steam pressure regulators, pump regulators, water pressure regulators, expansion traps, return steam traps, balance traps, relief valves for steam or water, damper regulators, steam separators, pump governors and receivers, blower valves and ball cocks, all of these being fully described and well illustrated in a new catalog for 1909 which is just received.

INDUSTRIAL ENGINEERING is a new magazine published in Pittsburg and edited by Robert Thurston Kent. It is aimed to cover in a general way the field of mechanical engineering. The first number deals largely with shop systems and problems.

SEVERAL NOVEL FEATURES in ice breaker construction are described in the 1909 Creasey Ice Breaker and Ice Users' Handbook, issued by Jos. S. Lovering Wharton, 3144 North 17th St., Philadelphia, Pa. A new type of ice breaker illustrated has the following innovations: The drum can be slid out of the frame horizontally through a gap, making lifting or dismanteling unnecessary; the delivery plate can be fixed in 2 positions to deliver the ice front or rear as desired; and the front plate has 3 adjustments for giving different sizes to the broken ice. Besides these improvements, the frame of the machine has been redesigned along more graceful and stronger lines. This booklet will be of interest to all who use broken ice because of its valuable tables and information on freezing ice cream, cold storage temperatures, specific heats, etc.

WHO MAKES WHAT is the title of a convenient directory of the hardware industry published by the Hardware Dealers' Magazine, of New York City. It has several different lists, the first of these being a list of the wholesale merchants throughout the country with brief descriptive item in regard to each. The second is a list of manufacturers showing the location, and third a classified list of products showing by cross reference number index the firms which make the different articles. The fourth list is of foreign merchants covering the entire commercial world. The fifth list gives an alphabetical directory of export houses, foreign buyers and commission houses who will deliver American goods in foreign countries. All together there are 350 pages of the list, the price of which is $1. It is conveniently arranged for reference and bears the hall mark of being complete and carefully made up.

ENGINE TYPE DIRECT-CURRENT GENERATORS, designed for general lighting and power service are described in a new bulletin issued by Allis-Chalmers Co. These machines are suitable for direct connection to steam, gas or oil engines and have many features of construction that have given them a well established reputation for reliability and satisfactory performance under widely varying conditions of service. Bulletin No. 1059 contains illustrations of installations where these machines may be seen in operation. The various parts are also shown separately and among them is the patented brush holder which is provided with an adjustable helical spring. The body of the brush holder is mounted on a brush stud, while the brush and tension finger are allowed to move freely to follow any irregularities of the commutator.

GEM CITY BOILER CO., of Dayton, Ohio, in a catalog just issued describes the Russell Water Softener, which is a new design for this kind of installation, continuous in operation and treating water by automatic action. The catalog explains in full the details of the system and its method of operation.

SHOP HEATING is a treatise by F. R. Still containing practical suggestions as to methods and apparatus. It is published and sent free for the asking by the American Blower Co., Detroit, Mich. And it is best to ask, for the book is worth reading.

TANKS AND TOWERS for water supply service are illustrated in a catalog and price-list No. 17, issued

by the U. S. Wind Engine & Pump Co., of Batavia, Illinois.

D'OLIER ENGINEERING CO., of Trenton, N. J., makes among other things centrifugal pumps, and in its Catalog T describes the horizontal type of single and stage pumps and illustrates the construction of these by halftones and line drawings.

THE JONES STOKER IN MARINE SERVICE is the title given to a series of booklets issued by the Underfeed Stoker Co. of America. One of these describes the lake steamer James E. Davidson, which carries iron ore from Duluth, Minn., to Lake Erie ports and returns with cargoes of coal. She is equipped with Niclausse water-tube boilers fitted with Jones stokers. The booklet describes the boat and the stoker installation and gives a letter from G. A. Tomlinson, the owner, showing a coal saving of 25 per cent by the use of the stokers. A second booklet of the series is on the hydraulic dredge Francis T. Simmons, used by the Lincoln Park (Chicago) Board of Commissioners, in which Jones stokers were installed primarily to avoid making smoke. These stokers have not only served this purpose as was expected, but made possible considerable increase in efficiency of the boilers and the use of a cheaper coal.

BULLETIN E P No. 3, issued by the DuBois Iron Works, DuBois, Pa., contains interesting descriptions of its motor, gasoline engine and belt-driven pumps, with capacities of from 25 to 1,000 gal. a minute, made in types for every service. The bulletin shows in detail the arrangement for the different kinds of driving and the method of construction of the water end of the pumps.

FROM GOULDS MFG. CO., of Seneca Falls, N. Y., we have received an attractive catalog advertising the Empire double-acting well force pumps and also a booklet which describes the construction of these pumps and gives lists of capacities and sizes and the retail prices. Besides the Empire the Goulds Co. makes the Seneca and the Advance double-acting force pumps and the distributing force pump made for windmill use.

IN AN ATTRACTIVE FOLDER entitled Bell Ringing Transformers, the General Electric Co. illustrates and describes a small transformer for use in connection with the operation of electric call bells. The idea in the use of the transformer is the elimination of the usual battery for this purpose, and the utilizing of current from the lighting circuit. The transformer will operate successfully on voltages ranging from 100 to 130 at the usual lighting frequency. The number of this folder is 3765.

DEAN BROS. STEAM PUMP WORKS, of Indianapolis, has recently published its catalog No. 72, which gives descriptions of its hydraulic-pressure pumps built in both duplex and simple style, driven by motor, steam or other power.

IN THE MARCH ISSUE of the Publicity Magazine, which is issued by the Underfeed Stoker Co. of America, are found descriptions of a number of plants in which the Jones Under-Feed stokers are installed, and items of interest in regard to the performance of these stokers. The plants include a water works, a gas and electric central station, a glove factory and a department-store building.

MARCH BULLETIN of the American School of Correspondence shows the new location of the school at 58th St. and Drexel Boulevard in Chicago. It gives also a view of the new administration building and contains portraits of the faculty and instructors and of the writers who have contributed to the textbooks of the school. In the text pages, besides a complete statement of the purposes of the school and what it can do for students, the outline of each course is stated in detail, so that a prospective student can see exactly what subjects he will get in any given course.

A. S. CAMERON STEAM PUMP WORKS of New York sends out to its friends each month a handsome illustrated calendar, that for April, having as a headpiece a 3-color reproduction of Herter's painting, "The Helpmate."

AMERICAN METAL HOSE CO.'S booklet shows new styles of copper and galvanized steel hose made in 2 styles, one having "ball bearing" the other "interlocking" joints for connecting the successive rings. This hose is made in styles for steam, oil, water or air. The booklet is interesting and comes from 173 Lafayette St., New York.

IN THE STURTEVANT ENGINEERING SERIES 2 bulletins have just been issued dealing with economizers. One treats of their use in the power plants of textile mills, the other in steel mills. Both show views and diagrams of installations, put in by the B. F. Sturtevant Co. of Hyde Park, Mass., and are interesting reading matter.

THE CURRENT STOCK LIST of the Scully Steel & Iron Co. of Chicago shows on hand a large assortment of steel in plates, squares and rounds, rivets, bolts, small tools for engine rooms, boiler shops and structural steel works, and a line of specialties, including the Everlasting blowoff valve, the Parmelee wrench, and Yale & Towne chain hoists.

THE PRODUCTS OF KENNICOTT, which, translated, is the Products of the Kennicott Water Softener Co., are beautifully illustrated in a new catalog just received from the company. These products include the Kennicott water softener, the Bonus-Kennicott water-tube boiler, tanks and towers for water plants, and car tanks.

AMERICAN SCHOOL OF CORRESPONDENCE, with its usual activity and effort, is sending out a handsome circular showing in detail the value of the Cyclopedia of Drawing to anyone wishing to study the subject or a reference book for the practicing draftsman. The subjects covered are the elements of all branches of drawing, including mechanical, architectural, perspective and freehand, the use of water colors, lettering, making of shop drawings, machine design, the different branches of architectural work, and blueprinting. A special offer of less than half price is made in this circular.

ECONOMICAL OPERATION OF YOUR POWER PLANT is the title of a booklet by the Williams Gauge Co., of Pittsburg, Pa. They ask if this is a problem and then proceed to show you how to solve it and how it has been solved in a good many other plants. The booklet will be sent to subscribers on request.

PAMPHLET No. 3768, just issued by the General Electric Co., contains a comprehensive list of motor-starting and speed-controlling devices, both automatic and non-automatic starters. Each device is illustrated and briefly described, and the pamphlet will be of value to all interested in any way with motor drive.

A HANDSOME PUBLICATION devoted to the Curtis steam turbine-generator has recently been is-

sued by the General Electric Co. under the number 4653. This bulletin is quite elaborate so far as details of construction are concerned, containing interior views and cross-sections of various parts of turbine and generator. It describes large and small turbines of vertical and horizontal types, and contains illustrations of numerous representative Curtis turbine installations. The bulletin will be found to contain much of interest to the central station manager.

NELSON VALVES stands out from the cover of a handsome book which is issued by the Nelson Valve Co. The cover is attractive and inviting, and the inside bears out the cover's promise. It is a valve book rather than catalog, with description of the different kinds of valves and discussion of the advantages of each. It's worth having and worth studying.

STEAM TURBINES, a bulletin (No. 5370) issued by the Western Electric Co., is a complete description with plenty of illustrations of the Rateau turbine as made in this country by the company.

RENSSELAER POLYTECHNIC INSTITUTE BULLETIN shows the buildings and laboratories recently erected at that school and gives an idea of the courses in the different branches of engineering. This is the oldest school in civil engineering in the country, and has recently added courses in mechanical and electrical engineering, the gift of one million dollars by Mrs. Russell Sage permitting the erection of splendid laboratories for these subjects.

FOR ANY KIND OF ENGINES mechanical oiling is desirable, and the Lavigne oiler with micrometer adjustment has been especially designed to meet the requirements of high speed machinery, such as steam engines, gas and gasoline engines. A booklet describing the oiler is just received from the Lavigne Mfg. Co., of Detroit, Mich., showing in detail the special features, which are no springs and no check valves.

TRADE NOTES

WRITING IN REGARD to the Harris Smokeless furnace, W. D. & C. H. Le Sueur of Nashville, Tenn., say:

"Gentlemen—We have used your Harris Smokeless furnace on our 66 in. by 16 ft. Erie City return tubular boiler for the past 2 years and are pleased with the work it does. We are convinced that there has been a saving of 25 per cent in coal. There is very little smoke when the furnace is properly fired.

"We do not hesitate to say that we believe the Harris Smokeless furnace will do all that is claimed for it."

AMONG THE NEW THINGS in the gas engine field is a magneto made by the Hess-Bright Mfg. Co. of Philadelphia, which is remarkably clean cut in its outline and is free from all projections and hollows to catch dirt and moisture.

GILSON MFG. CO. is building a large addition to its plant at Port Washington, Wis., to facilitate the manufacture of the Gilson "Goes Like Sixty" gasoline engines.

AJAX VALVE CO., of Chicago, is placing on the market a line of valves with a novel feature in the form of elastic metal disks stamped to a true seating surface from rolled metal. The disks are held in place by 3 bent lugs, so that there is no nut to work loose. The makers issue an interesting folder describing these and other advantages.

DU BOIS IRON WORKS has recently appointed James L. Kimball as New England representative, with offices at 53 State St., Boston, Mass., also the James F. Marshall Co., 608 Chestnut St., Philadelphia, general sales managers for eastern Pennsylvania, Delaware, and the southern half of New Jersey.

PRESSURES OF 5,000 LB. are being successfully carried by valves made by the Homestead Valve Mfg. Co. of Pittsburg, Pa. Several recent sales, a large number repeat orders, prove that the Homestead valve is good not only for a blow off valve, but to handle the highest known pressures.

LIBERTY MFG. CO. states, in regard to reports circulated that it is going out of business or has suffered loss of important employes, that these reports are without foundation. A few unimportant employes have left the company, none of whom, however, had anything to do with the management or was responsible for its business policy or the character of its product. The company assures us that it is still in business and will continue under the old management, which feels that the changes have been beneficial rather than otherwise, as all men who left have been replaced by men of better experience and higher ability.

A NEW KIND OF GAGE GLASS, which is unbreakable from change in temperature, has recently been perfected and placed on the market by the Advance Packing & Supply Co. The company claims that a test of resistance made by sprinkling the glasses under high steam pressure with cold water showed that this glass withstood a pressure of 225 lb.

TO THOSE WHO HAVE OCCASION to travel between cities served by the Chicago and Alton R. R. an innovation of interest is the dental lavatories now placed in the Pullman cars. This avoids the cleansing of teeth in the regular lavatories, removing a possible source of the spread of disease as well as making the morning douche much more wholesome. It is another of the Alton's pioneer advances, worthy of hearty commendation.

THE FORMER AMERICAN BOILER ECONOMY CO., of Philadelphia, manufacturers of the Copes boiler feed regulator and the Copes pump governor, has been consolidated with the Northern Equipment Co., Old Colony Bldg., Chicago, Ill., which will assume all obligations of the former company, including guarantees to replace free of cost any part of any Copes regulator that may develop a defect within 5 yr. from the date of purchase. The branch offices of the American Boiler Economy Co., viz.: Tribune Bldg., New York City, Oliver Bldg., Boston, 226 East Pleasant St., Baltimore, and the Frick Bldg., Annex, Pittsburg, will be continued under the style of the Northern Equipment Co., while the sale of Copes regulators will be handled in Philadelphia by the Adjustable Grate Bar Co., North American Bldg. The Northern Equipment Co. announces that it will continue to install the Copes regulators on 60 days' free trial. The following recent sales to prominent concerns are mentioned: Nichols Copper Co., the Delaware & Hudson R. R. Co., the Clark Thread Co., the Consolidated Gas Co. of New York and the Boston Elevated Ry. Co.

A LIST OF SALES recently made by the York Mfg. Co. is as follows: Garber, Reist & Co., Lititz, Pa., one 6-ton refrigerating plant for their creamery; Daugherty Bros., Olney, Texas, one 10-ton ice-making plant; J. F. B. Atkins, Bordentown, N. J., one 10-ton ice-making plant; C. H. Oliphant, Elmer, N. J., one

10-ton ice-making plant; Wistner & Castner, Steubenville, Ohio, one 60-ton ice-making plant; R. D. McKelvey Co., Spring Creek, Pa., one 10-ton refrigerating plant; C. H. Oliphant, Elmer, N. J., one 4-ton refrigerating plant for a creamery for Daretown, N. J.; J. A. Brandt, Steelton, Pa., one 6-ton refrigerating plant for a bottling house; M. Kondolf, Rochester, N. Y., one 40-ton ice-making plant; Giant Powder Company, Victoria, B. C., one 20-ton refrigerating plant; West Chester Ice Co., West Chester, Pa., one 30-ton ice-making plant; Harry Shellenberger, York, Pa., one 2-ton refrigerating plant for a slaughter house; J. B. Maltby, Inc., Corning, N. Y., one 30-ton ice-making plant; Alex. Campbell Milk Co., Brooklyn, N. Y., one 30-ton refrigerating and 15-ton ice-making plant; Hershey Baking Co., York, Pa., one 2-ton refrigerating plant for bakery; L. P. Wilson, Hyannis, Mass., one 3-ton refrigerating plant for a grocery; George Collinge, Conneaut, Ohio, one 2-ton refrigerating plant for a meat market; West Penn Cold Storage Co., New Haven, Pa., one 30-ton compression side; Gloucester Ice Mfg. Co., Gloucester, N. J., one 35-ton ice-making machine and apparatus; Hanover Creamery Co., Hanover, Pa., one 10-ton refrigerating and 4-ton ice-making plant; Florida Brewing Co., Tampa, Fla., one 25-ton freezing and distilling system; Corry Ice Co., Corry, Pa., one 30-ton freezing and distilling system; St. Nicholas Hygeia Ice Co., New York City, one 50-ton freezing and distilling system, also replacing present double-acting compressors with 40-ton single-acting compressors; Natural Ice Co., Plainfield, N. J., one 40-ton freezing and distilling system; Moerlbach Brewing Co., Rochester, N. Y., 25-ton freezing system; Crystal Ice Co., Washington, D. C., one 35-ton plate freezing system; Warner County Workhouse, Allegheny, Pa., one 10-ton refrigerating plant; Westinghouse Church Kerr & Co., one 30-ton refrigerating and ice-making plant for Nassau Hotel, Long Beach, N. Y.; Louis Stultz, for Keyport, N. Y., one 25-ton ice-making plant; Peter Breidt City Brewing Co., Elizabeth, N. J., one 100-ton compression side; Zalac & Pavlinac, Etna, Pa., one 8-ton refrigerating plant for a meat market; Wm. N. McNabb, Wheeling, W. Va., one 8-ton refrigerating plant; Miners Farms, Chazy, N. Y., two 10-ton refrigerating machines and plant for a dairy; Searchlight Gas Co., Warren, Ohio, one 10-ton refrigerating plant; C. B. Combstock, Pittsburg, Pa., one 6-ton refrigerating plant for Western Penitentiary; Harbison Dairies, Rushland, Pa., one 6-ton refrigerating plant; Main Creamery Co., Providence, R. I., one 6-ton refrigerating plant; Perry Bros., Manhattan, Kans., one 10-ton refrigerating plant; O'Conner & Wittner, Syracuse, N. Y., one 4-ton refrigerating plant for a restaurant; H. S. Galbraight, Poughkeepsie, N. Y., one 8-ton refrigerating plant; J. W. Cunningham, Long Beach, N. J., one 15-ton ice-making plant; Consumers' Ice Co., Beaumont, Texas, one 30-ton ice-making plant; Hagerstown Ice Co., Hagerstown, Md., one 15-ton ice-making plant.

WANTED

"Positions Wanted" advertisements not exceeding 50 words for subscribers to Practical Engineer will be inserted twice free of charge. "Help Wanted" and special advertisements 25 cents a line.

POSITION.

By first class marine, stationary and electrical engineer; twenty years' experience as engineer and electrician. Good machinist, steam fitter and general power plant mechanic. Understand making all necessary repairs. Not afraid of work. Sober, man of family. South preferred. State salary. Address Box 100, care Practical Engineer. 5-2

POSITION.

By young man, age 39, married, electrician, T. B. E. W. Has fair knowledge of taking care of low pressure boilers and engines and electric plants. Steady and can offer good references. Eight years' experience. Address Charles C. Gladwin, 249 East 45th street, New York City. 5-2

POSITION.

As superintendent in plant under 1,000 H. P., or engineer in plant over 1,000 H. P. Six years' experience with A. C. and D. C. dynamos, high speed and Corliss engines. Strictly sober and steady; moderate salary to start; references. Address Electrical Engineer, Box 79, South Dayton, N. Y. 5-2

POSITION.

Railroad clerk and telegraph operator, 21 years old, college education, wishes position pertaining to shipping and receiving freight with some firm. Could also assist in drafting room. Address Box 112, New Castle, Dela. 5-2

POSITION.

By technical graduate, 32 years old. Five years' experience with A. C. and D. C. machines and equipments, all details of substation construction and operation. Have also had experience with steam. Desire position as assist superintendent or foreman of power plant, hydraulic or steam. Prefer South or West. Address Box 101, care Practical Engineer. 5-2

POSITION.

By young man in machine shop, with mechanical engineer, or in drafting room. Graduate of International Correspondence School in mechanical drawing. Age 27, good habits, not afraid of work. Address H. J. Postlewait, Box 23, Dayton, Pa. 5-2

POSITION.

By young man, 20 years old, as oiler and wiper in an engine and dynamo room. Have completed I. C. S. course in dynamo running. Some experience in steam engineering. Strictly sober, good references. Address J. Evert Snell, Bunker Hill, Miami Co., Indiana. 5-2

POSITION

As electrician of manufacturing or power company, by young man, single, strictly sober, graduate of A. S. C. in electrical engineering. Two years' station experience. Left charge of 3,000 H. P. central station to attend college. Now ready for engagement. A1 reference. Moderate salary to start. Write, Verde Harbaugh, Ashland, Ohio. 4-2

POSITION

Electrician, 12 years' experience. Can take charge of mill work. Considered an expert on mine equipment, mining machines, motors, also electric traveling cranes and full mill equipment. Can give best of references. Address F. C. Beck, Bridgeport, Ohio. 4-2

POSITION

To take full charge of small power or lighting plant, or as assistant in large one. Married man, aged 31. Ffteen years' experience wiring line work and care of motors and generators. Handled men for last 10 years. Best references from present employers. Address Box 99, care of Practical Engineer. 4-2

POSITION

By young man as engineer's helper, or fireman in a power plant, good worker; no bad habits. Some experience in traction engineering and has nearly completed I. C. S. course. Age 24. Will come on trial if not too far. Address Box 214, Spicer, Minn. 4-2

FOR SALE

60 steel storage tanks, 6,000 gallons' capacity. Good as new. Double riveted, extra well built. Suitable for storage of oils, waters or liquids of any kind. 100 steam pumps. Get our prices on engines, boilers and electrical machinery. All sizes and kinds. Chicago House Wrecking Co., 35th and Iron Sts., Chicago. 4 tf

ENGINEERS AND MECHANICS

To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. 4 tf

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